METG
Montana Environmental Trust Group

Montana Environmental Trust Group, LLC
Trustee of the Montana Environmental Custodial Trust
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By Electronic Mail and Hand Delivery

August 1, 2014

Betsy Burns
RCRA Project Officer
USEPA Region 8, Montana Operations Office
Federal Building
10 West 15th St., Suite 3200, Mail Code: 8MO
Helena, MT 59626

Dear Betsy:

The U.S. Environmental Protection Agency (USEPA) issued its conditional approval of the draft Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) (the Draft Phase II RFI) in a letter dated April 29, 2014 (see Attachment A). In fulfillment of the approval conditions identified in USEPA's letter and consistent with its obligations under the First Modification to the 1998 RCRA Consent Decree, the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (Custodial Trust), hereby submits this letter and supporting documentation detailing the actions taken to finalize the Phase II RFI.

USEPA Condition 1 –

USEPA's letter states: Submittal of a technical memorandum detailing the purpose and scope of the proposed fate and transport modeling. The fate and transport modeling is a tool that will support corrective measure evaluations in the Corrective Measures Study (CMS) and will provide information for the Strategic Groundwater Plan for long term monitoring. The technical memorandum will be provided to EPA by August 1, 2014.

Custodial Trust Response to USEPA Condition 1

The technical memorandum requested by USEPA is provided in Attachment B. The Custodial Trust has appended a copy of *Revised Work Plan for Solute Transport Model Development, Former East Helena Smelter*, prepared by NewFields, dated June 25, 2014, to provide additional technical details on the scope of the fate and transport modeling activities.

USEPA Condition 2 –

USEPA's letter states: Correction of the following technical errors within the draft Phase II RFI. The Custodial Trust will provide replacement pages as an erratum by August 1, 2014.

a) Shew Ridge Soil Stockpile - The Shew Ridge soil stockpile has been removed and placed in CAMU 1. Correct figures in Section 6 (arsenic, cadmium, copper, lead and zinc) to reflect current site conditions.
b) Groundwater Plume Maps. Correct Figures 11-25a to 11-25d and Figures 11-26a to 11-26b to reflect ranges of contamination relative to the groundwater maximum contaminant levels (or MCLs) for arsenic and selenium.
c) Batch Adsorption Test Results for Selenium. Correct the transposed results for selenium samples (EH-139 and RFI2SB-3) in Table 6-17.

Custodial Trust Response to USEPA Condition 2

a) Shew Ridge Soil Stockpile – The revised Section 6 figures are provided in Attachment C.
b) Groundwater Plume Maps – The revised figures for the arsenic and selenium plumes are provided in Attachment C.
c) Batch Adsorption Test Results for Selenium – The revised Table 6-17 is provided in Attachment C.

USEPA Condition 3 -

USEPA's letter states: Prepare a surface soil sampling and analysis plan to characterize the nature and extent of the site-related constituents of concern in surface soil for the former ASARCO properties that were not addressed in the Phase II Investigations. Once completed, this work will satisfy the requirements of Paragraphs l0.b and 26 to 33 in the First Modification to the 1998 RCRA Consent Decree.

Custodial Trust Response to USEPA Condition 3

The Custodial Trust will continue to work with USEPA to develop the approach, scope, and schedule for developing the surface soil sampling and analysis plan (SAP) and related characterization work, which will be submitted to USEPA by year-end 2014.

Subject to the Custodial Trust's development and submittal of the SAP identified in Condition 3 above, this transmittal, including the following attachments, represent the RFI Final Report as set forth in the First Modification to the RCRA Consent Decree:

Letter - Attachment A

USEPA Conditional Approval Letter

Letter – Attachment B

Technical Memorandum – Fate and Transport Model Purpose and Scope

Letter - Attachment C

Revised Figures and Table:

Figures 6-5b to 6-5f. Arsenic Concentrations in Subsurface Soil (various depths)
Figures 6-6b to 6-6f. Cadmium Concentrations in Subsurface Soil (various depths)
Figures 6-8b to 6-8f. Copper Concentrations in Subsurface Soil (various depths)
Figures 6-10b to 6-10f. Lead Concentrations in Subsurface Soil (various depths)
Figures 6-15b to 6-15f. Zinc Concentrations in Subsurface Soil (various depths)
Figures 11-25a to 11-25d. Dissolved Arsenic Concentrations in Groundwater, [various dates]
Figures 11-26a to 11-26b. Dissolved Selenium Concentrations in Groundwater, [various dates]
Table 6-17. Batch Adsorption Test Results for Selenium

Please do not hesitate to contact me with any questions pertaining to this transmittal.

Sincerely,

Cynthia Brooks

Cynthia Brooks, President
Montana Environmental Trust Group, LLC
By: Greenfield Environmental Trust Group, Inc., Member
By: Cynthia Brooks, President

cc: Without Attachments
Lauri Gorton—Custodial Trust
Julie DalSoglio—US EPA-8
Joe Vranka—US EPA-8

cc: With Attachments
Chuck Figur—US EPA-8
Denise Kirkpatrick—MDEQ

Certification

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Montana Environmental Trust Group, LLC
Not Individually But Solely In Its Representative Capacity As
Trustee of the Montana Environmental Custodial Trust

Cynthia Brooks

By: Greenfield Environmental Trust Group, Inc., Member
By: Cynthia Brooks, President

Attachment A
USEPA Conditional Approval Letter

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8, MONTANA OFFICE
FEDERAL BUILDING, 10 West 15th Street, Suite 3200
HELENA, MT 59626-0096
Phone 866-457-2690
http://www.epa.gov/region08

Ref: 8MO

VIA EMAIL

April 29, 2014

Cynthia Brooks
Montana Environmental Trust Group, LLC
Trustee of the Montana Environmental Custodial Trust
P. O. Box 1230
East Helena, MT 59635

Re: Conditional Approval of the draft Phase II RCRA Facility Investigation (RFI)

Dear Cindy:

EPA has reviewed the draft Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (Phase II RFI) prepared for the Trust by GSI Water Solutions, Inc. in May 2011, and compared the submitted draft to the approved Phase II RFI Work Plan (Phase II RFI Work Plan, Hydrometrics, 2010). Based on the review, EPA is conditionally approving the draft Phase II RFI. The conditions for approval are:

1. Submittal of a technical memorandum detailing the purpose and scope of the proposed fate and transport modeling. The fate and transport modeling is a tool that will support corrective measure evaluations in the Corrective Measures Study (CMS) and will provide information for the Strategic Groundwater Plan for long term monitoring. The technical memorandum will be provided to EPA by August 1, 2014;
2. Correction of the following technical errors within the draft Phase II RFI. The Custodial Trust will provide replacement pages as an erratum by August 1, 2014 -
    a. Shew Ridge soil stockpile – The Shew Ridge soil stockpile has been removed and placed in CAMU 1. Correct figures in Section 6 (arsenic, cadmium, copper, lead and zinc) to reflect current site conditions;
    b. Groundwater Plume Maps – Correct Figures 11-25a to 11-15d and Figures 11-26a – 11-26d to reflect ranges of contamination relative to the groundwater maximum contaminant levels (or MCLs) for arsenic and selenium.
    c. Batch Adsorption Test Results for Selenium – Correct the transposed results for selenium samples (EH-139 and RFI2SB-3) in Table 6-

17.

3. Prepare a surface soil sampling and analysis plan to characterize the nature and extent of the site-related constituents of concern in surface soil for the former ASARCO properties that were not addressed in the Phase II Investigations. Once completed, this work will satisfy the requirements of Paragraphs 10.b and 26 to 33 in the First Modification to the 1998 RCRA Consent Decree.

Additionally, Section 6.2.2.3 detailed deviations from the approved Phase II RFI Work Plan. This approval letter serves as written documentation that the deviations were discussed and approved by EPA and MDEQ:

1. Elimination of test pits in the Rail Car Staging Area (RCSA-2, RCSA-5 and RCSA-8); Unpaved Facility Are (UPS-SS-5); Thornock Lake (TL-003); Acid Facility (SS-28); and Onsite Rail Corridor (RC-SS-22).
2. Elimination of soil boring RFI12SB-19 and relocation of soil borings RFI2SB-3 and RFI2SB-11.
3. Elimination of installation of groundwater monitoring well EH-140 and associated soil samples.

Completing the above detailed modifications to the draft Phase II RFI will address outstanding requirements in the approved Phase II RFI Work Plan; comply with the First Modification to the 1998 RCRA Consent Decree; and comply with RCRA regulations and guidance documents.

Sincerely,

Betsy Burns

Betsy Burns
Remedial Project Manager

Cc: Lauri Gorton – Custodial Trust
Chuck Figur – US EPA Region 8
Joe Vranka – US EPA Region
Julie DalSoglio – US EPA Region
Marc Weinreich – Custodial Trust
Denise Kirkpatrick – Montana DEQ

Attachment B
Technical Memorandum – Fate and Transport Model Purpose and Scope

Fate and Transport Model Purpose and Scope

PREPARED FOR: Custodial Trust

PREPARED BY: CH2M HILL

DATE: July 24, 2014

The U.S. Environmental Protection Agency (USEPA) issued its conditional approval of the draft Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) (the Draft Phase II RFI) in a letter dated April 29, 2014. In fulfillment of Condition No. 1 listed in USEPA's letter, the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (the Custodial Trust) prepared this brief technical memorandum to detail the purpose and scope of the groundwater fate and transport (F&T) modeling for the East Helena Facility.

A robust and appropriately calibrated F&T model is an invaluable tool for evaluating various corrective measures as part of the corrective measures study (CMS) process. The purpose of the F&T model is to help analyze, illustrate, and predict the behavior of contaminants in groundwater under different cleanup scenarios. The F&T model will be used to evaluate the effects of potential corrective measures, including interim measures (IMs), on groundwater concentrations and plume geometry. This information will be used during the CMS to evaluate expected remedy performance and to inform the relative benefits to groundwater associated with different corrective measures.

The modeling activities are key elements of the Custodial Trust's integrated site cleanup strategy being implemented at the East Helena Facility. The components of the East Helena site cleanup strategy are outlined below.

1) Establishing an integrated approach to evaluating groundwater corrective actions within the overall CMS/RCRA corrective action framework. Specific activities include:
    a) Preparing an updated groundwater conceptual site model that integrates the results of sitewide routine groundwater monitoring; Upper Lake dewatering, Wilson Ditch dewatering, and Prickly Pear Creek (PPC) Bypass (South Plant Hydraulic Control [SPHC]) monitoring; and groundwater modeling.
    b) Conducting Tier II source control/groundwater remedy evaluations in a two-phased approach, starting with a screening-level evaluation to eliminate remedial alternatives based on feasibility and cost, and more fully evaluate remedial alternatives that would warrant further consideration.
    c) Using available tools, including F&T modeling, to quantify groundwater benefits of the planned SPHC and Evapotranspiration (ET) Cover System IMs, potential soil removal actions, and other source control measures/groundwater remedies that may be deemed appropriate based on the Tier II evaluations.
    d) Petitioning for a Controlled Ground Water Area (CGWA) as an institutional control put in place in tandem with planned IMs and potentially other corrective measures.
2) Integrating groundwater-related CMS activities and schedules with proposed IMs in a manner that allows the IM construction schedules to flex depending on Tier II evaluation results.
3) Conducting IM performance monitoring as part of the CMS to evaluate performance and provide information to support a final remedy proposal, consistent with the objectives established in the draft CMS Work Plan.

To support the East Helena site cleanup strategy, the F&T model (see attachment for details of the purpose and scope of the F&T modeling efforts) will be used:

- To simulate the current extent of the arsenic and selenium plumes. *This step will be used to calibrate the F&T model to current groundwater flow and geochemical processes, to confirm that the groundwater model (coupled flow and F&T model) is an appropriate tool for use in the East Helena cleanup project.*
- To predict groundwater responses and help assess the benefits to groundwater quality of ongoing and planned IMs, including SPHC and ET Cover System. *Available monitoring data indicate the lowering of groundwater levels achieved with the Upper Lake drawdown activities and construction of the PPC Bypass have resulted in reduced contact of contaminated soil with groundwater. F&T modeling will more fully quantify the anticipated benefits to groundwater quality of both the SPHC and final ET Cover System.*
- To support Tier II screening level and detailed evaluations of source control and groundwater remedy alternatives, by evaluating their potential benefits to groundwater. *The F&T model will be used as a tool to objectively compare the effectiveness of the different alternatives evaluated, and identify additional corrective measures that may be deemed appropriate and cost effective to augment ongoing and planned IMs.*
- To aid in design of a long-term monitoring program to assess the performance of the final remedy (in terms of IMs and other corrective measures that may be needed to augment the IMs). *F&T modeling will help guide the selection of an appropriate monitoring well network and monitoring time frame.*
- To provide groundwater information necessary to support the CGWA petition. *F&T modeling will provide future estimates of both the arsenic and selenium plume configurations.*

Additional details on the proposed groundwater modeling effort are provided in *Revised Work Plan for Solute Transport Model Development, Former East Helena Smelter*, prepared by NewFields, dated June 25, 2014, presented as an attachment to this technical memorandum.

Attachment

Revised Work Plan for Solute Transport Model Development, Former East Helena Smelter, prepared by NewFields, dated June 25, 2014

Technical Memorandum

Date: June 25, 2014

To: Lauri Gorton, Bob Anderson

From: Cam Stringer and Joel Jacobson

Subject: ***Revised*** **Work Plan for Solute Transport Model Development Former East Helena Smelter**

1.0 INTRODUCTION

This memorandum documents the approach to fate and transport modeling designed to support selection and implementation of corrective measures (i.e., remedial actions) to address groundwater contamination associated with the former East Helena smelter located near the City of East Helena, Montana. The scope of work described in this memorandum builds on groundwater flow modeling already completed for the project.

The Phase II RFI Work Plan (Hydrometrics 2010) set forth three objectives for groundwater modeling at the Facility which include:

1. Update the previous groundwater flow model to simulate the current flow field and groundwater flow rate over the expanded model domain;

2. Simulate current arsenic and selenium plume geometry in terms of the distribution, concentrations, and apparent migration rates observed for arsenic and selenium in recent years; and

3. Perform predictive simulations to evaluate potential effectiveness, aquifer response, and preliminary design considerations for various groundwater management and treatment scenarios that may be developed.

NewFields (2013) completed steady-state and transient calibration of a groundwater flow model that fulfilled the first objective above. The second and third objectives require design and calibration of a fate and transport model. An initial Draft Solute Transport Model Work Plan was submitted to the Montana Environmental Trust Group (METG) on July 22, 2013 detailing the approach for a fate and transport model. This memorandum is a revised version of the original work plan.

Previously, AMEC (2012) developed a work plan to guide the overall groundwater modeling process and fulfill the objective of the Phase II RFI Work Plan. A groundwater flow model was developed using MODFLOW (AMEC 2012) and the model was calibrated to steady-state and transient conditions (AMEC 2012; NewFields 2013). Calibration results have demonstrated the flow model is capable of simulating groundwater flow under a variety of hydrogeologic conditions within a reasonable range of error. The flow model has been used along with particle tracking techniques to evaluate the effects of potential interim remedial measures (IMs) planned for the former smelter site and surrounding area on groundwater flow direction, gradients, and fluxes. Particle tracking results have been helpful in evaluating potential changes in groundwater flow direction and general contributions from various source areas.

This memorandum describes the approach for developing and implementing the contaminant fate and transport model for the former East Helena smelter and surrounding area to support the evaluation and selection of appropriate remedial actions and fulfill the second objective of the Phase II RFI Work Plan.

1.1 MODELING GOALS AND OBJECTIVES

The overall goals of the transport model are to simulate the current extent of the arsenic and selenium plumes, support the cleanup project planning, design, and management, and evaluate potential groundwater responses to proposed IMs and final corrective measures (CMs). Specific objectives commensurate with these goals include:

1. Refine current conceptual models of potential groundwater contaminant source areas. Considerable work has previously focused on identification and characterization of specific or localized sources of contaminants to groundwater (primarily arsenic and selenium). **Figure 1** shows currently identified potential sources of groundwater contaminants, with the specific sources characterized to various levels. Through calibration of the transport model, a greater understanding may be gained regarding the extent, depth, and geochemical characteristics of some of these potential source areas. During the calibration process the source area terms (i.e., source area characteristics) will be adjusted to best replicate the existing and historic groundwater plume geometries and concentrations. Information obtained on specific source areas through the calibration process will be used to predict the effects of additional IMs/CMs. Potential refinements to the conceptual site model may include adjustments to groundwater/surface water interactions, source area load concentrations, and refinement of retardation and decay terms.

2. Evaluate effects on groundwater chemistry from currently planned IMs which include the South Plant Hydraulic Control (SPHC) project (draining Upper and Lower Lakes, dewatering Wilson Ditch, and realigning Prickly Pear Creek), excavation of Tito Park soils, and placement of an evapotranspiration soil cover over the Facility. The calibrated flow and transport model will be used to predict the effects of the currently proposed IMs on the former smelter and downgradient groundwater quality. Initial predictive simulations will use simplifying assumptions for changes in model parameters (e.g., redox).

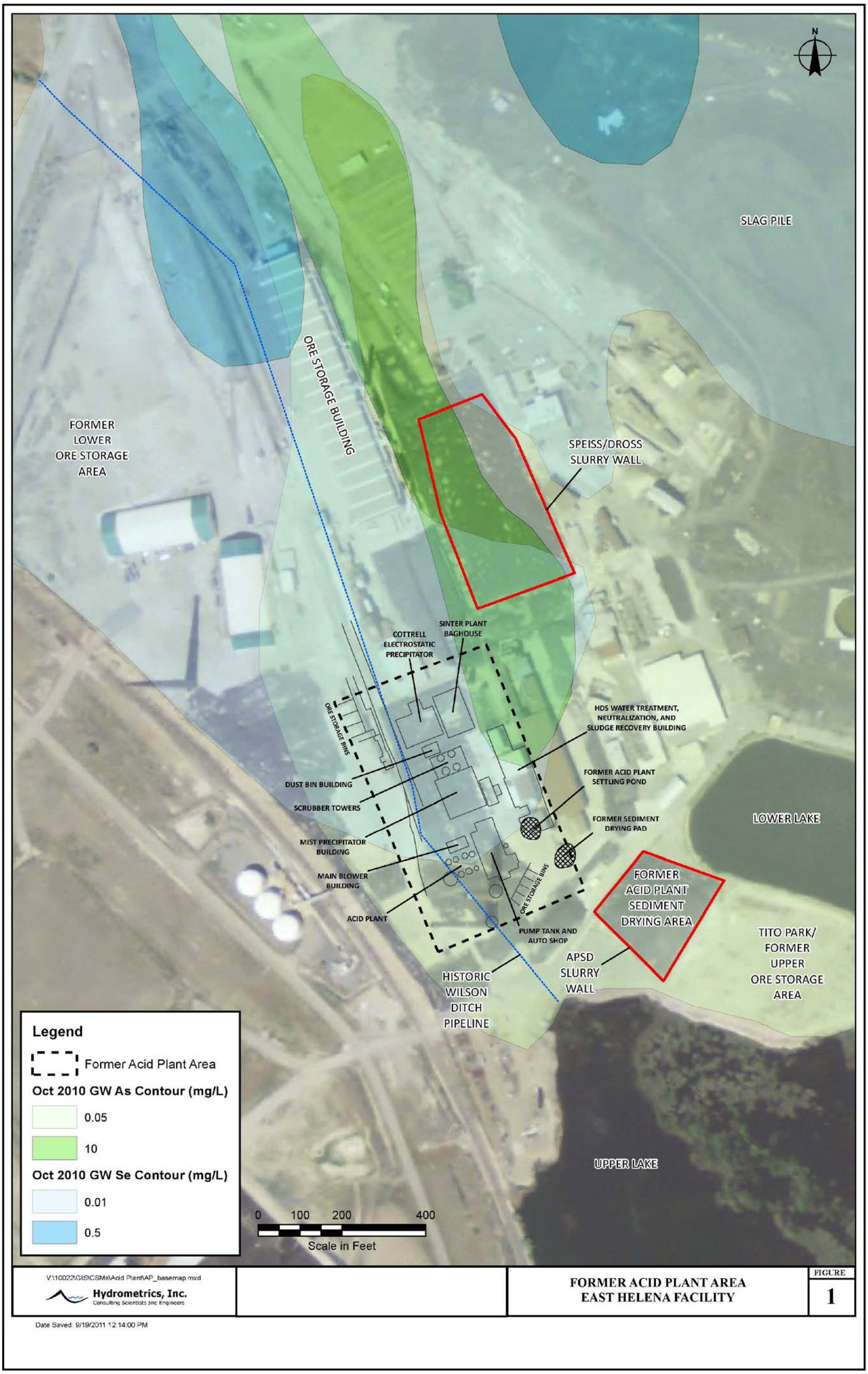
3. Evaluate effects of other potential IMs/CMs. Pending assessments of the effectiveness of currently planned IMs, either through the flow and transport model and/or through post-implementation groundwater monitoring, additional remedial measures may be warranted. In order to facilitate project planning and scheduling, the transport model will be used to predict the effects on groundwater quality of other potential remedial activities. Other potential

activities could include, but are not necessarily limited to, mitigation of previously identified source areas such as the west selenium area, Acid Plant area, north plant site, and other potential source areas (**Figure 1**). These potential source areas are described later in this document and in various other project documents, including the recent source removal evaluation technical memorandum (CH2M Hill 2013a).

4. Aid in implementation/management of a Controlled Groundwater Area (CGWA). Current plans call for implementation of a CGWA on and downgradient of the former smelter. The CGWA will serve as an institutional control for the project, to minimize potential exposures to groundwater contaminants. The flow and transport models will be used in design, implementation, and management of the CGWA.

The modeling objectives outlined above are based on current project plans and needs, and may be modified or expanded in the future pending project developments. In conjunction with the previously developed numerical groundwater flow model (NewFields 2013), the transport model will serve as an integral tool for project planning, design, and management. Under the four general objectives outlined above, the transport model will aid in addressing a multitude of project issues (i.e., the effects of SPHC on groundwater plume migration rates and directions, the effects of eliminating flow in Wilson Ditch on groundwater flow and contaminant migration patterns, and source(s) of arsenic in groundwater west of the former smelter/Lamping Field, etc.). Development of the transport model will also fulfill objectives and recommendations presented in a number of previous project documents, including the Phase II RFI Work Plan (Hydrometrics 2010), the 2012/2013/2014 Interim Measures Work Plans (CH2M Hill 2012, 2013b, 2014), and the recent soil removal evaluation tech memo (CH2M Hill 2013a).

P:\350.0024 East Helena\Admin\Work Plans\ST Model Work Plan\Figure_1.mxd



Source: Hydrometrics

Acid Plant
Former East Helena Smelter
East Helena, Montana
FIGURE 1

NewFields

2.0 CONTAMINANT TRANSPORT CONCEPTUAL MODEL

This section summarizes the current understanding of contaminant fate and transport, focusing on the primary contaminants of concern (COC): arsenic and selenium. Information below is based on review of available soil, groundwater and geochemical data, and information presented in METG (2011) which describes the current understanding of fate and transport in and around the Facility. The conceptual model will form the basis for design and construction of the fate and transport model discussed in Section 3.0.

2.1 POTENTIAL SOURCES AND SOURCE AREAS

Potential sources of contaminants to groundwater have been evaluated in a number of previous studies. Hydrometrics (1999) provided a detailed evaluation of potential contaminant sources based on information available at that time. Asarco Consulting Inc. (ACI) conducted additional source identification and delineation as presented in a RCRA Facility Investigation (RFI) report (ACI 2005). The most recent information regarding contaminant sources was obtained through a 2010 Phase II RFI field investigation (METG 2011). Historically, periodic releases of process water through process circuit leaks or spills are believed to be primary sources of contaminant loading to plant site soils and groundwater. Plant process waters are known to have contained high concentrations of arsenic and/or selenium as well as other contaminants and to have been released to the environment on a frequent basis prior to the mid-1990s. Main areas of process water releases include Lower Lake, Acid Plant area, Speiss/Dross area, and Thornock Lake. All of these areas contained process ponds known to have leaked to various degrees.

The Acid Plant area is a known historic and current source of contaminant loading to groundwater. Historically, the Acid Plant settling pond (**Figure 1**), a 68 feet by 35 feet by 9 feet deep settling basin, was used to settle solids from the Acid Plant scrubber blowdown water. The settling pond leaked on a regular basis prior to 1992, releasing process water to the subsurface. Pre- and post-neutralization Acid Plant process water chemistry is shown in **Table 1**. **Table 1** indicates the Acid Plant process water contained high concentrations of several constituents including arsenic and selenium and a pre-neutralization pH of 1.9. Besides the settling pond, process water releases have been documented during the smelter operational phase at the scrubber blowdown area (**Figure 1**). The Acid Plant settling pond was replaced with a tank in 1992 and the settling pond was demolished and excavated in 1993. However, contaminated soils currently remain within the Acid Plant area, near the head of the main arsenic and selenium plumes (**Figure 1**).

The Speiss/Dross plant area included two process water features (speiss pond and speiss granulation pit), as well as nearby Thornock Lake (**Figure 2**). All of these features are known points of historic process water releases. Process water in the Speiss/Dross circuit had high arsenic concentrations, ranging from 1,500 to 3,500 milligrams per liter (mg/L), and alkaline pH (10 to 13). Although these features were removed and surrounding soils excavated in the 1990s, remaining soils in these areas are believed to act as ongoing sources of contaminant loading to groundwater. In 2007, a slurry wall was constructed around the Speiss/Dross area to reduce the migration of contaminated groundwater from the area. Based on current groundwater quality, the slurry wall appears to be at least partially effective at reducing the downgradient migration of contaminated water from the Speiss/Dross area. The Speiss/Dross slurry wall effectiveness will be evaluated further in 2014.

The process ponds described above are examples of historic sources of contaminant loading to subsurface soils and groundwater, with impacted soils acting as current sources. Several other current sources have been identified including Lower Lake, Tito Park/Upper Ore Storage area soils, Acid Plant sediment drying area (also enclosed by a slurry wall in 2006), and other potential sources such as the slag pile and resolubilization of secondary mineral cements within the aquifer matrix. As part of the transport model development, a complete inventory of historic and current groundwater contaminant sources and associated loading mechanisms will be compiled to aid in source term definition for the model.

Table 1. Acid Plant Circuit Water Quality – March 1998

Parameter	Scrubber Blowdown Water	Neutralized Scrubber Blowdown Water
pH (s.u.)	1.9	6.7
TDS (mg/L)	7248	9875
Chloride (mg/L)	1192	1790
Sulfate (mg/L)	5501	3779
Fluoride (mg/L)	148	42
Calcium (mg/L)	329	173
Sodium (mg/L)	301	2542
Arsenic (mg/L)	1867	1716
Cadmium (mg/L)	230	180
Mercury (mg/L)	2.06	0.81
Selenium (mg/L)	5.9	5.3
Thallium (mg/L)	37	31
Zinc (mg/L)	140	120

Note: s.u. = standard units of pH; mg/L = milligrams per liter; TDS = total dissolved solids.

2.2 PETROLEUM IMPACTED SOIL AND EFFECT ON GROUNDWATER EH

Previous investigations identified an area with petroleum hydrocarbons in subsurface soil and groundwater that affects groundwater redox conditions (Hydrometrics 1990; ACI, 2005; and METG 2011). METG (2011) indicates there is a relationship between groundwater redox and geometry of the arsenic and selenium plumes. High arsenic concentrations occur in the area impacted by petroleum that has very low Eh (approximately -250 mV, based on data from well DH-33), while dissolved selenium concentrations are low in this rea. Data indicate that arsenic concentrations are highest (i.e., arsenic is most mobile) under relatively reducing conditions (where iron and manganese oxide minerals available for arsenic adsorption are unstable). Selenium concentrations are lowest under these conditions.

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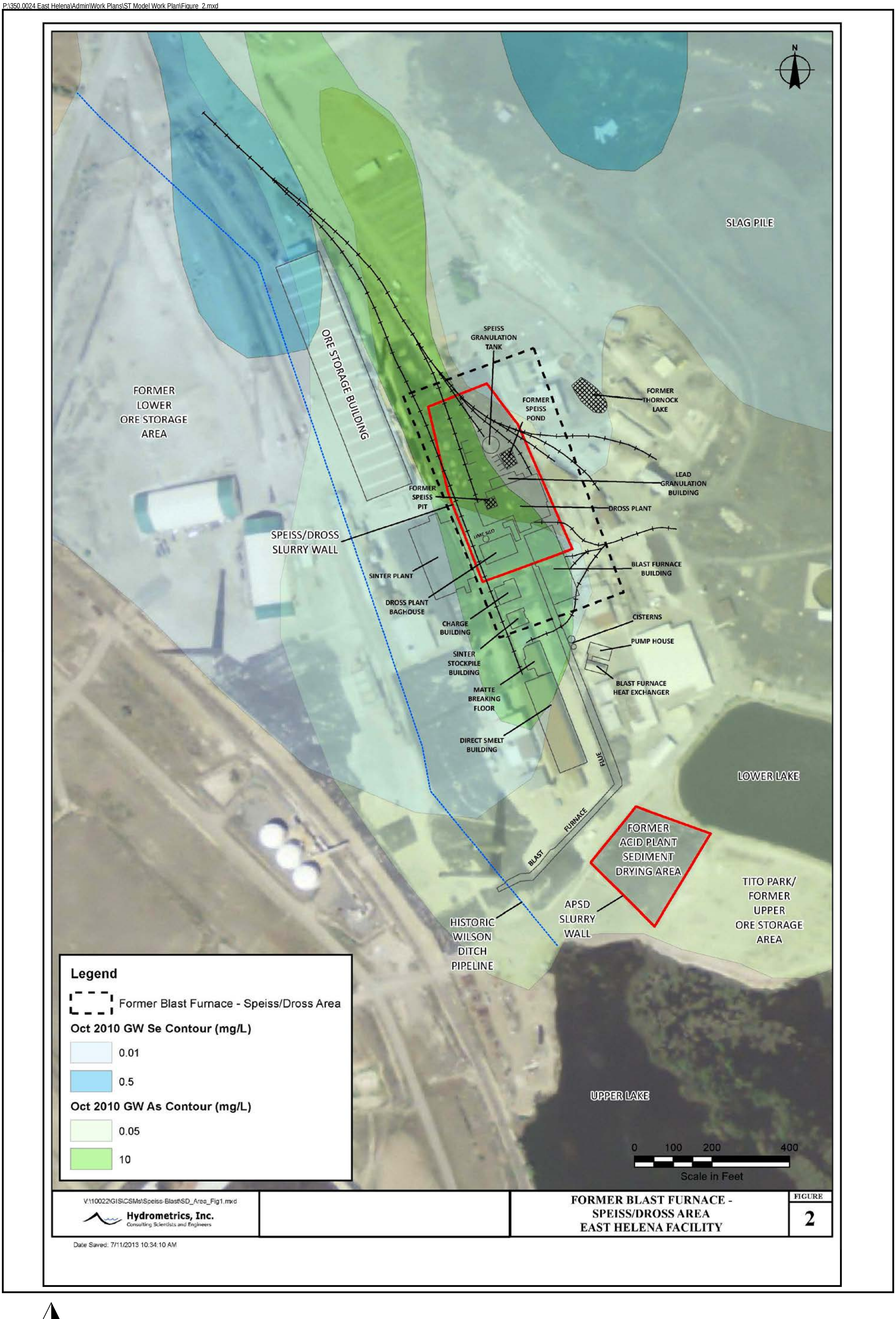


Source: Hydrometrics

NewFields

Speiss/Dross Area
Former East Helena Smelter
East Helena, Montana
FIGURE 2

2.4 CONTAMINANT GEOCHEMISTRY

A detailed description of the environmental chemistry of arsenic, metals (cadmium, copper, iron, lead, manganese, and zinc), and petroleum hydrocarbons was previously included in Section 8.2 of the CERCLA Comprehensive RI/FS (Hydrometrics 1990) and in Section 4.5 of the RCRA CC/RA (Hydrometrics 1999). A discussion of selenium geochemistry was also included in the Phase II RFI Work Plan (Hydrometrics 2010). It was concluded in these reports that the fate of arsenic and metallic contaminants is determined by their chemical properties and geochemical changes (e.g., pH, redox potential, ionic strength, etc.) that take place in the environment. The discussion below summarizes the environmental chemistry of arsenic and selenium, which were determined to be the contaminants of greatest concern in groundwater. Other COCs, such as antimony, have sources and chemistry similar to arsenic and/or selenium, and fate and transport of these constituents will be covered under the analysis of the primary COCs (arsenic and selenium). The objective is to provide context for an evaluation of the current arsenic and selenium groundwater plumes in subsequent sections of this memorandum.

2.4.1 Arsenic

Arsenate (HnAsO4n-3) is the most common oxidized aqueous species (+5 oxidation state or As(V)) and arsenite (HnAsO3n-3) is the most common reduced aqueous species (+3 oxidation state or As(III)). The level of protonation of arsenate and arsenite is a function of pH. Additionally thioarsenic (sulfur-containing As(III) species) may occur under sulfate-reducing conditions with depleted iron concentrations.

As show in in **Figure 3**, arsenic exists as a mixture of both As(III) and As(V) aqueous species in on-site and off-site groundwater (METG 2011). The precipitation of pure phase arsenic minerals is not likely in groundwater systems (EPA 2007). Arsenic transport in groundwater is typically affected by coprecipitation and adsorption/desorption mechanisms. Coprecipitation of arsenic with oxides and/or sulfides of iron and manganese is considered to be a likely sink for arsenic in groundwater in redox transition zones (i.e., where aquifer conditions change from reducing to oxidizing, or vice-versa). Both As(III) and As(V) have been reported to coprecipitate with hydrous iron and manganese oxides. As with other forms of arsenic, the long-term stability of arsenic precipitated minerals will depend on changes in redox, pH, and ionic composition of groundwater following implementation of remedial actions. Arsenic oxide minerals (related to air emission sludges and dusts) and sulfide solid-phases (present in slag and/or ore concentrate) could dissolve over time.

Adsorption of both arsenate and arsenite is pH dependent, and is also influenced by the concentration of other anions in solution that may compete for adsorption sites on aquifer materials. Langmuir et al. (2005) noted that arsenate adsorbed to hydrous ferric oxide is strongly bound at pH values below 8, and desorbed between pH 9 and 11. In natural conditions, As(V) sorbs more strongly than As(III) (Frost and Griffin 1977). The iron oxides and sulfides noted above that serve as potential coprecipitating minerals with arsenic are also apparently predominant as adsorptive materials in oxidizing and reducing conditions, respectively (EPA 2007). Adsorbents such as clays or organic matter may be less important adsorptive controls for anions, such as arsenate and arsenite, due to their negative surface charge under the range of natural pH.

ACI (2005) cited three lines of evidence suggesting coprecipitation and/or adsorption of arsenic with iron and manganese oxides is the dominant mechanism for attenuation of arsenic in groundwater:

- Iron and manganese oxides are abundant in aquifer materials on site;
- Sequential extraction analyses of aquifer materials indicate enrichment of arsenic in iron and manganese mineral phases; and
- Groundwater chemical data suggest removal of iron and manganese from groundwater by oxidation and subsequent precipitation, providing a mechanism for coprecipitation and fresh oxide surfaces for adsorption of arsenic.

2.4.2 Selenium

Selenium may exist in multiple oxidation states in the aqueous phase, including selenide (Se(-II)), selenite (Se(IV)), and selenate (Se(VI)), or solid phases including elemental selenium (Se(0)) and metal selenides (Se(-II)) (EPA 2007). The Se(IV) and Se(VI) states commonly occur as the oxyanions SeO3-2 (selenite) and SeO4-2 (selenate). Selenium speciation and, consequently, selenium mobility in groundwater is dependent on pH and redox conditions (**Figure 4**).

In contrast with arsenic, attenuation of selenium in soils is positively correlated with the formation of reducing conditions in groundwater. Selenite behaves like phosphate and is strongly adsorbed by hydrous ferrous oxides (although sorption decreases significantly above pH values of about 8.5). Selenite may also precipitate with manganese at higher pH if excess manganese is present. According to EPA (2007), selenate (the more oxidized form) is analogous to sulfate, with little adsorption and high mobility.

Elemental selenium (Se(0)) or highly insoluble metal selenides may also precipitate under reducing conditions resulting in very low dissolved selenium concentrations in groundwater. As is discussed by METG (2011) this is evidenced by the fact that dissolved selenium concentrations at the site are very low in areas with low Eh (i.e. area of petroleum impacts). Reoxidation of elemental selenium to more mobile selenite or selenate oxyanions is relatively slow, suggesting that Se(0) phases formed in soil may be important long-term sinks for selenium.

3.0 FATE AND TRANSPORT MODEL DEVELOPMENT

Fate and transport modeling will simulate the conveyance of dissolved chemicals in groundwater and take into account the processes of advection, physical dispersion, and chemical reactions. Fate and transport modeling for the Facility will use a calibrated groundwater flow model coupled with a calibrated contaminant transport model. A project groundwater flow model has been developed using MODLFOW and is calibrated to both steady-state and transient data sets.

MT3DMS (Zheng and Wang 1999), coupled with the calibrated MODFLOW model, will be used to develop the transport model. MT3DMS is capable of simulating transport of solutes such as selenium and other metals under a variety of groundwater flow and chemical conditions. Contaminants can be added to groundwater from unsaturated and saturated soils and contaminated surface water.

The following section describes the approach to developing the solute transport model.

3.1 ADDITIONAL FLOW MODEL CALIBRATION AND SIMULATION

Additional calibration of the groundwater flow model is required to support fate and transport modeling. The fate and transport model will be calibrated based on long-term chemistry data sets going back at least as far as 2002. The existing groundwater flow model is calibrated to steady-state conditions based on average 2011 groundwater and surface water elevations and transient conditions using groundwater and surface water elevation data collected between September 2011 and November 2012. To support development of the contaminant transport model, the flow model needs to be calibrated to additional steady-state groundwater data collected from 2002 to 2005 (to simulate groundwater flows prior to installation of the Spiess/Dross and Acid Plant slurry walls) and from 2008 to 2011 (to simulate groundwater conditions during the period between installation of the slurry walls and initiation of the Upper Lake Drawdown Test). In addition, the groundwater flow model will be calibrated to transient conditions represented by data form the period between November 2013 and May 2014. Updating and calibration of the flow model will follow procedures and use targets described in NewFields (2013). The model will be further updated in 2014 as warranted, based on additional data collected and any refinements to the groundwater conceptual model.

3.2 FATE AND TRANSPORT MODEL DESIGN

The transport model will be designed based on the hydrogeochemical conceptual model and calibrated flow model.

The following is a summary of the steps that will be followed in developing the fate and transport model:

3.2.1 Data Evaluation and Analysis

Existing site data regarding the concentration and distribution of contaminants in groundwater and soil and data from Synthetic Precipitation Leachate Procedure (SPLP), Sequential Batch Leach (SBL), Sequential Extraction, and Batch Adsorption tests will be reviewed and evaluated. The SBL method is based on the SPLP method except that Upper Lake water was used as the leach solution as a surrogate for "ambient" groundwater. In addition, SBL tests include multiple sequential extractions as opposed to a single extraction used in SPLP tests. Test results will be used to evaluate source characteristics, relative availability of leachable arsenic and selenium in soil, and assess the potential for adsorption/desorption of arsenic and selenium in different portions of the former smelter.

3.2.2 Source Term Development

Pore water concentrations for arsenic and selenium in soil, sediment, and slag will be estimated based on SPLP and SBL results multiplied by conversion factors. Conversion factors (CFs) will be based on observed relationships between the concentration of contaminant in the leach test solids and extracts.

Pore water concentrations will be calculated using the following formula:

PW = L x CF

CF = (V / M) x ρ x SY x 20

Where: PW = concentration in pore water (mg/l)
L = representative concentration of SPLP or SBL leachate
CF = conversion factor
V = volume of SPLP/SBL solid (L)
M = mass of SPLP/SBL solid (g)
ρ = bulk density of SLPL/SBL solids (g/L)
SY = Specific Yield (unitless)
20 = 1000g extract solution per 50 g solids used in SPLP tests

L terms and CFs will be determined differently for unsaturated and saturated zone soils. L concentrations will be generated for each source area in each model layer based on site-specific soil data. If necessary, further refinement of source areas in each layer may be made, and multiple L concentrations may be calculated for these refinements. Selection of L concentrations and CFs for the unsaturated and saturated zones is described in the following two sections.

3.2.2.1 Unsaturated Zone Soils

Based on review of unsaturated zone SPLP arsenic and selenium results for all single-extract tests, there is no relationship between solid arsenic (or selenium) concentrations and SPLP concentrations for samples from the same source. In general, SBL results are not available for samples collected in unsaturated zone sediments. The minimum, maximum, median, and mean concentrations were determined for all available SPLP extracts for each source area in the unsaturated zone layer. Median concentrations were consistent for SPLP tests completed on borehole sediments within each source area. In some cases, average concentrations were skewed due to outlier maximum concentrations. Therefore, median SPLP extract concentrations will be used to represent the initial L terms. The minimum and average results from SPLP extracts will be used to constrain model input concentrations for arsenic and selenium during calibration.

Estimated pore water concentrations will be used as source concentrations for unsaturated zones in the model. PW concentrations will be added to recharge from the Recharge Package in the model and used as the source term.

3.2.2.2 Saturated Zone Soils

SPLP and SBL data were plotted with respect to solid As and Se concentrations for each source area in the saturated zone. Review of the data indicates there is a logarithmic relationship between the extract concentrations and the solid concentrations in the saturated zone sediments. Therefore, the L term for saturated zone arsenic and selenium will be calculated using curve-fit equations for observed relationships between concentrations in SPLP solids and the first extract of SBL tests for each source area. This is a conservative approach. The concentration of As or Se decreased in consecutive SBL extracts (sequential leach tests 2 through 8). If warranted, the concentrations calculated from curve-fit relationships in subsequent SBL extractions may be used to represent the L term. Concentrations of arsenic and selenium in downgradient wells will be compared to SBL extract concentrations to determine which extract sequence is most representative.

SBL tests run on samples from the area impacted by petroleum hydrocarbons do not exhibit a relationship between extract and solid concentrations. Therefore, in these areas, a median SPLP concentration will be used for the L term. Furthermore, the minimum and average results from SPLP extracts in petroleum impacted sediments will be used to constrain model input concentrations for arsenic and selenium during calibration.

For saturated soil, fluid flux for each source zone will be estimated based on flow model output, and the flux will be multiplied by the PW to obtain a mass loading rate. The calculated mass loading rate will be input for each zone in MT3DMS using the Source/Sink Mixing Package.

3.2.3 Transport Parameters

Effective Porosity

Initial estimates of effective porosity will be developed based on literature values for different zones of predominantly silt, sand, or gravel.

Dispersivity Coefficients

Initial estimates of dispersivity coefficients will be calculated using the method described in Xu and Eckstein (1995).

Retardation and Decay

<u>Arsenic</u>

There is evidence that sorption of arsenic is controlled by dissolved arsenic concentrations, redox, and pH conditions in the aquifer. The reactive transport of arsenic will be simulated using a retardation factor which is a function of bulk soil density, moisture content, chemical adsorption properties, pH, and redox potential. Distribution coefficients (K_d) for arsenic will be developed based on adsorption test results (METG 2011) which are representative of aquifer material throughout the site. Averaged Langmuir parameters will be used to create a general Langmuir adsorption isotherm relating the mass of arsenic adsorbed per bulk unit soil to dissolved arsenic concentrations.

The K_d will be used to calculate a retardation factor used in the groundwater model using the following equation from Fetter (2001):

$$\text{Retardation factor} = 1 + (p_b/\theta)(K_d)$$

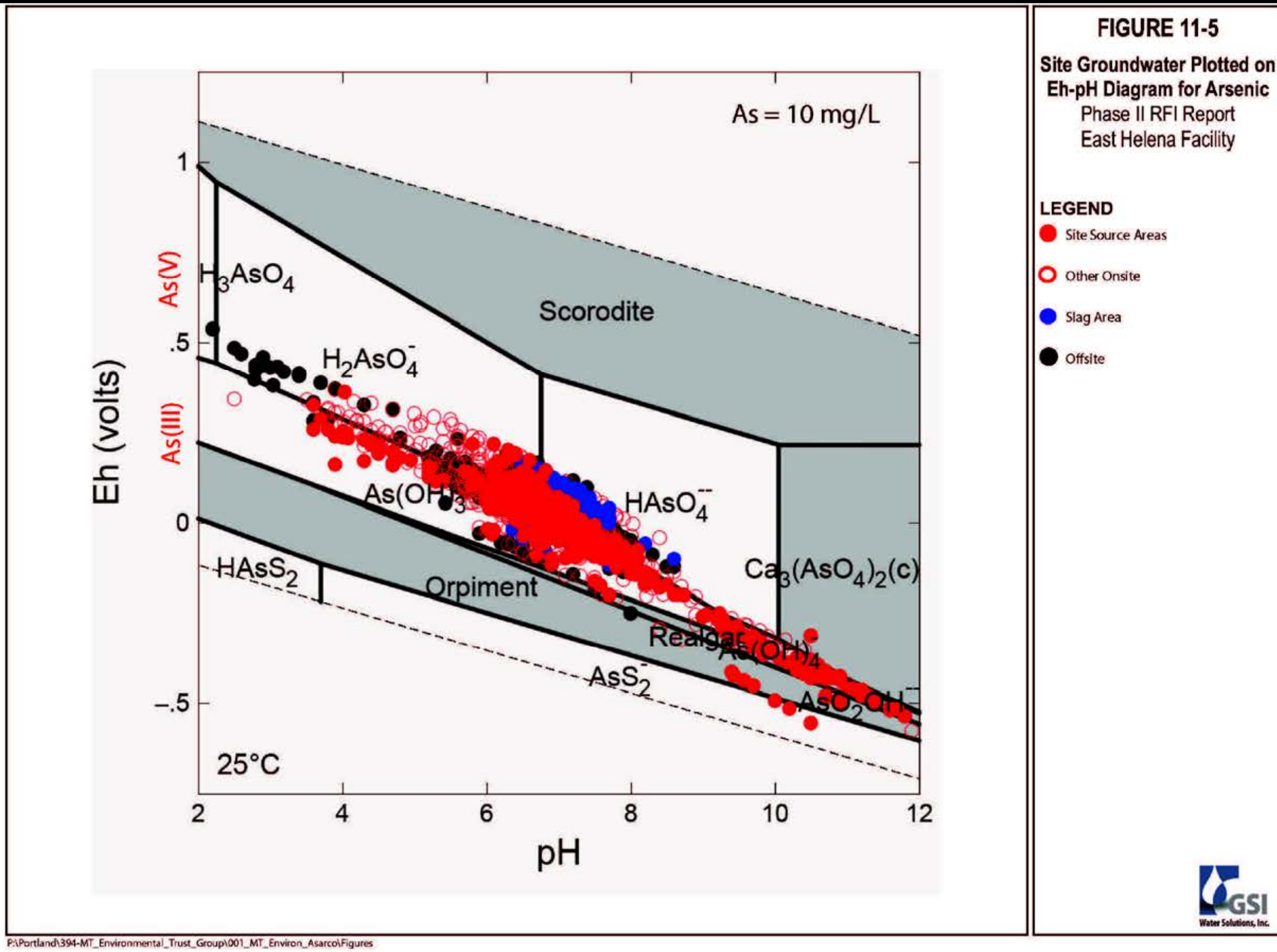
Where:

p_b = dry bulk mass density of the soil (mass per volume);

θ = volumetric moisture content of the soil (dimensionless);

K_d = distribution coefficient for the solute with the soil (volume per mass); and

Decay = decay factor (dimensionless).



Source: METG (2011)

Arsenic Eh/pH Diagram
Former East Helena Smelter
East Helena, Montana
FIGURE 3

NewFields

K_d values will be adjusted within a reasonable range as part of the calibration process.

Decay coefficients will be used to simulate coprecipitation of arsenic. Initial estimates of decay coefficients will be obtained from literature values summarized in Wilkin and Ford (2006) and USEPA (2007).

Selenium

An assessment of dissolved selenium in conjunction with other physical and chemical parameters in the aquifer indicates that selenium mobility is primarily controlled by redox and pH conditions. Estimated field Eh values will be calculated from selenite/selenate and/or arsenate/arsenite redox pairs (as described for arsenic pairs in the previous section). Ratios of selenium species will be calculated where data are available and estimated field Eh data will be paired with field pH values and plotted on a pourbaix diagram. This information will be used to determine the predominant selenium species in groundwater throughout the site (**Figure 4**). During initial model calibration, the broad assumption will be made that selenate remains soluble (mobile) in groundwater while selenite may remain mobile, sorb to iron hydroxides, or precipitate with manganese or other metals, and elemental selenium will precipitate and become immobile in the aquifer. Decay will be used in the transport model to simulate precipitation. Initial estimates of decay coefficients will be based on precipitation rates found in literature (Tokunaga et al. 1994; Zawislanski and Zavarin 1996; Herbel et al. 2003).

Literature indicates that manganese can precipitate with Se(IV) species above pH 7, depending on the concentration of dissolved manganese (USEPA 2007). Other decay coefficients may be used to represent this boundary condition based on evidence of the presence of manganese. Alternatively, a retardation factor may be used to represent selenite sorption to hydrous ferrous oxides and manganese oxides. The retardation factor would be generated using K_ds from adsorption test results of samples presented in the Phase II RFI (METG 2011) and literature values. A comprehensive summary of selenite adsorption on individual soil minerals is documented in Zachara et al. (1994). Further investigation of groundwater chemistry data and redox conditions near the petroleum impacted area will be completed to address site areas where selenite is being potentially attenuated due to adsorption. Additional speciation and mineralogy work planned for 2014 will support this effort.

3.3 FATE AND TRANSPORT MODEL CALIBRATION

Calibration of the coupled flow and transport model will consist of simulating transport of arsenic and selenium in groundwater over a period of time. Calibration of the transport model will likely focus on simulating the past 10 years of changes in arsenic concentrations at specific wells where such data are available. For selenium, which has a shorter sampling history, similar calibration activities will be conducted for locations where time-series records of selenium concentrations are available. The following subsections describe the calibration process for the transport model.

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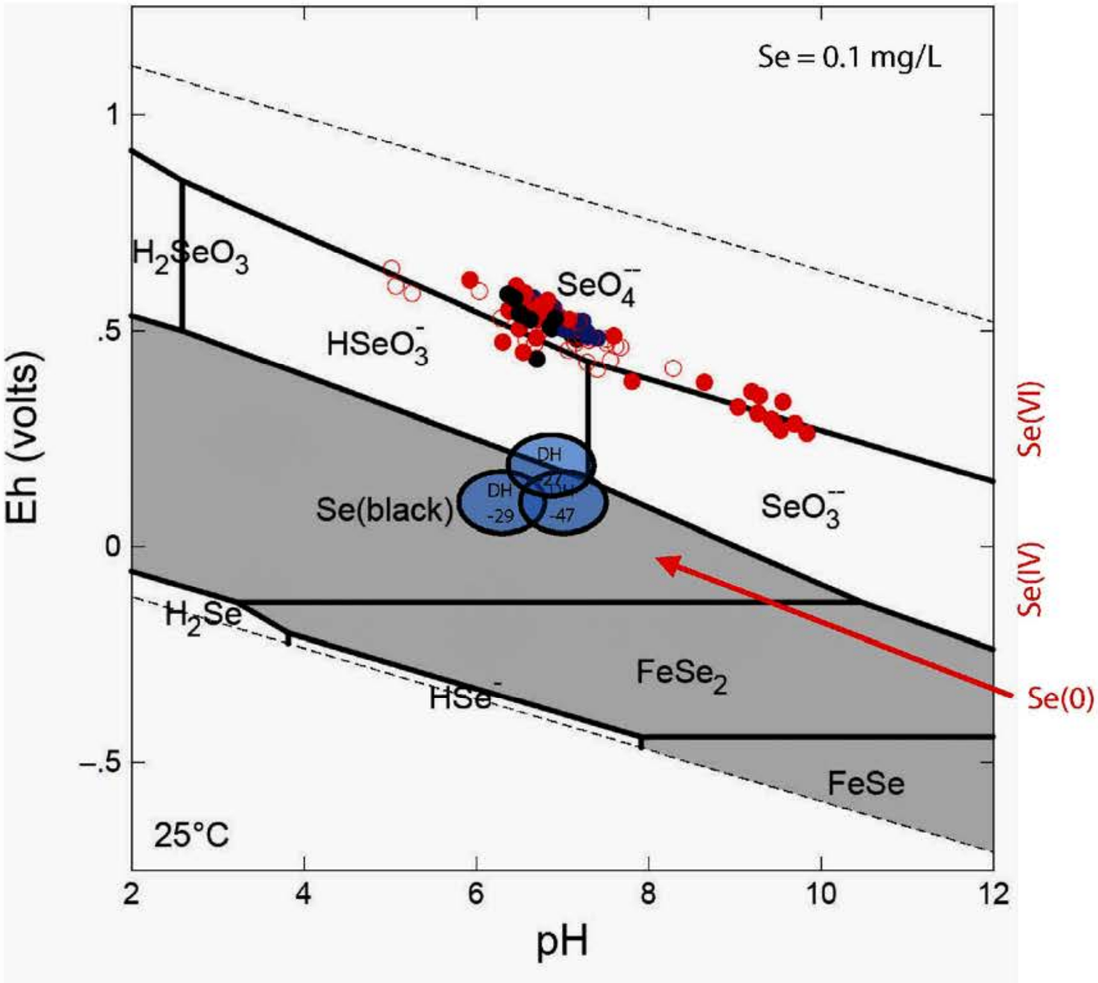

FIGURE 11-6

Site Groundwater Plotted on Eh-pH Diagram for Selenium

Phase II RFI Report

East Helena Facility

LEGEND

- Site Source Areas
- Other Onsite
- Slag Area
- Offsite

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Source: METG (2011)

Selenium Eh/pH Diagram
Former East Helena Smelter
East Helena, Montana
FIGURE 4

NewFields

3.3.1 Target Selection

Arsenic and selenium data and plume maps for at least three periods (e.g., 2002, 2008, and 2011) will be selected for use as targets. For example, arsenic concentrations in wells near the Speiss/Dross, Acid Plant, Lower Lake, and northern Facility boundary have exhibited changes in arsenic concentrations over the last 10 years. Time-concentration data for wells in these areas will likely be selected for targets. Time-concentration data for selenium in groundwater are available for a shorter period. Wells exhibiting discernible selenium concentration trends (e.g., DH-62, SDMW-5, EH-62) may be selected as calibration targets.

3.3.2 Procedure

Steady-state flow fields will be generated from output for the calibrated groundwater flow field. Simulation of constituent transport will be completed by importing mass to the transport model using initial source term estimates and the model to simulate successive steady-state flow fields representing the following periods.

- Period 1 – Plant shut down to demolition and slurry wall construction in Speiss/Dross and Acid Plant areas (2002 through 2005)
- Period 2 – Post slurry wall construction (2008 through 2010)
- Period 3 – Pre-Upper Lake drawdown (January through October 2011)

Calibration will proceed by iteratively adjusting model inputs such as source concentrations, effective porosity, dispersivity coefficients, retardation factors, and decay coefficients to reduce the difference between simulated plumes and concentrations and targets.

As part of the calibration, source areas will be evaluated and refined. Areas such as the west selenium hot spot that have little soil data but exhibit high concentrations in groundwater will be evaluated during calibration to refine the likely extent, location, and concentration of source material.

3.3.3 Evaluation

The difference between simulated and observed concentrations will also be evaluated statistically for each calibration run. Calibration will continue until the difference between simulated and observed values has been minimized. To evaluate this residuals for each target will be calculated as the difference between the log of the simulated and observed concentrations. Statistics will be calculated from the residuals including mean, absolute mean, and standard deviation. Plume maps based on simulated concentrations will also be compared qualitatively to those based on measured values and evaluated in terms of how well they match. In addition, simulated time-concentration plots will be compared to target plots based on measured values and judged for goodness of fit. Sensitivity Analysis

A sensitivity analysis will be conducted on the calibrated transport model to evaluate uncertainty in results related to estimates of transport parameters. Transport parameters will be adjusted within reasonable ranges, and simulated concentrations will be compared to calibrated results to assess sensitivity of individual parameters on model results.

4.0 REFERENCES

AMEC, 2012. Initial Flow Model Design and Calibration, East Helena Site. Technical Memorandum. October 9, 2012.

Asarco Consulting Inc. (ACI), 2005. Phase I RCRA Facility Investigation Site Characterization Report East Helena Facility. Prepared February 2003. Revised July 2005.

CH2M Hill, 2012. Former ASARCO East Helena Facility Interim Measures Work Plan. Prepared for The Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust. April.

CH2M Hill, 2013a. Evaluation of Soil Removal Alternatives at the East Helena Former ASARCO Smelter Site. Technical Memorandum. August.

CH2M Hill, 2013b. Former ASARCO East Helena Facility Interim Measures Work Plan - 2013. Prepared for The Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust. November.

CH2M Hill, 2014. Former ASARCO East Helena Facility Interim Measures Work Plan - 2014. Prepared for The Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust.

Fetter, C.W., 2001. Applied Hydrogeology, Fourth Edition. Prentice Hall, Upper Saddle River, New Jersey.

Frost, R.R., and R.A. Griffin, 1977. Effect of pH on adsorption of arsenic and selenium from landfill leachate by clay minerals. Soil Sci. Soc. Am. J. 41, 53-57.

Herbel, M.J., Blum, J.S., Oremland, R.S., and Borglin, S.E., 2003. Reduction of Elemental Selenium to Selenide: Experiments with Anoxic Sediments and Bacteria that Respire Se-Oxyanions. Geomicrobiology Journal. Vol. 20, iss. 6, 2003. P. 587-602.

Hydrometrics, 1990. Comprehensive Remedial Investigation/Feasibility ASARCO, Inc. East Helena Montana. February 1990.

Hydrometrics, 1999. Current Conditions/Release Assessment East Helena Facility. Prepared September 1998. Revised January 1999.

Hydrometrics, 2010. Phase II RCRA Facility Investigation Site Characterization Work Plan East Helena Facility. May 2010.

Juillot, F., P.H. Ildefonse, G. Morin, G. Calas, A.M. de Dersabiec, and M. Benedetti, 1999. Remobilisation of Arsenic from Buried Waste at an Industrial Site: Mineralogical and Geochemical Control. Applied Geochemistry. 14, 1031-1048.

Langmuir, D., Chrostowski, P., Vigneault, B., and Chaney, R., 2005. Issue Paper on the Environmental Chemistry of Metals. Revised January 25, 2005.

Montana Environmental Trust Group (METG), 2011. Draft Phase II RCRA Facility Investigation Site Characterization Report for the East Helena Facility, East Helena, Montana. Prepared for: Montana Environmental Trust Group. March.

NewFields, 2013. DRAFT Groundwater Flow Model Calibration Refinement, Transient Verification, and Interim Measures Support, East Helena Site. Technical memorandum. August.

Nickson, R.T., J.M McArthur, P. Ravenscroft, W.G. Burgess, and K.M. Ahmed, 2000. Mechanism of Arsenic Release to Groundwater, Bangladesh and West Bengal. Applied Geochemistry. 15, 403-413.

Tokunaga, T.K., S.R. Sutton, and S. Bajt, 1994. Mapping of selenium concentrations in soil aggregates with synchrotron x-ray fluorescence microprobe. Soil Science 158: 421-434 (1994).

U.S. EPA, 2007. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 1 – Technical Basis for Assessment and Volume 2 – Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium. October 2007.

Wilkin, R.T. and R.G. Ford, 2006. Arsenic solid-phase partitioning in reducing sediments of a contaminated wetland. Chemical Geology 228: 156-174 (2006).

Xu, M. and Y. Ecksein, 1995. Use of Weighted Least-Squares Method in Evaluation of Relationship between Dispersivity and Fields Scale. Ground Water, Vol. 33, No. 6, November-December.

Zawislanski, P.T. and M. Zavarin, 1996. Nature and rates of selenium transformations: A laboratory study of Kesterson ReservoirKesterson Reservoir soils. Soil Science Society of America Journal 60: 791-800.

Zheng, P and P. Wang, 1999. "MT3DMS: A Modular Three-Dimensional, Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems". Prepared for Headquarters, U.S. Army Corps of Engineers.

Attachment C
Revised Figures and Table

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Table 6-17. Batch Adsorption Test Results for Selenium
Phase II RFI Report, East Helena Facility

Selenium Results	Downgradient (Lamping Field)						Plant Site
Sample Location	**EH-70**	**EH-138**	**EH-138**	**EH-139**	**EH-138**	**EH-139**	**RFI2SB-3**
Depth Interval	**35-37' bgs**	**40-42' bgs**	**75-77' bgs**	**40-42' bgs**	**75-77' bgs**	**40-42' bgs**	**10-12' bgs**
Initial Concentration	0.10	0.10	0.10	0.10	5.07	5.07	0.777
Source Well	EH-111				DH-66		DH-6
Soil:Solution Ratio	**72-hr-Equilibration Concentration**						
1:4	*0.13*	*0.13*	*0.14*	*0.13*	5.0	4.8	*0.86*
1:10	*0.13*	*0.13*	*0.13*	*0.13*	*5.4*	*5.3*	*0.82*
1:20	*0.13*	*0.13*	*0.13*	*0.12*	*5.3*	*5.5*	*0.82*
1:40	*0.13*	*0.13*	*0.12*	*0.12*	*5.1*	*5.5*	*0.83*
1:60	*0.13*	*0.13*	*0.13*	*0.12*	*5.4*	*5.5*	*0.81*
1:100	*0.13*	*0.13*	*0.12*	*0.12*	*5.2*	*5.2*	*0.80*

Selenium Results	Plant Site					East Plume	West Plume
Sample Location	**RFI2SB-6**	**RFI2SB-18**	**RFI2SB-20**	**RFI2SB-20**	**RFI2SB-21**	**DH-74**	**RFI2-SB10**
Depth Interval	**2.5-5' bgs**	**10-16.5' bgs**	**30-32' bgs**	**40-42' bgs**	**30-52' bgs**	**115-117' bgs**	**15-27' bgs**
Initial Concentration	0.777	0.777	0.777	0.777	0.777	0.777	5.32
	DH-6					DH-6	DH-66
Soil:Solution Ratio	**72-hr-Equilibration Concentration**						
1:4	*2.2*	*1.2*	*0.81*	*1.4*	*0.79*	*0.83*	*5.4*
1:10	*1.6*	*1.2*	*0.81*	*1.2*	0.76	*0.78*	*5.3*
1:20	*1.3*	*1.2*	*0.81*	*1.1*	*0.83*	*0.77*	*5.4*
1:40	*1*	*1.1*	*0.81*	*1*	*0.83*	*0.84*	*5.5*
1:60	*0.96*	*1.1*	*0.81*	*0.89*	*0.82*	*0.84*	*5.5*
1:100	*0.91*	*1.0*	*0.83*	*0.88*	0.76	*0.79*	*5.5*

Notes:

Values in grey shaded cells and italics denote post-equilibration concentrations greater than initial concentrations.

Table obtained from Hydrometrics, Inc.: Section 2 Tables.xlsx/2-3-6; 2-3-7

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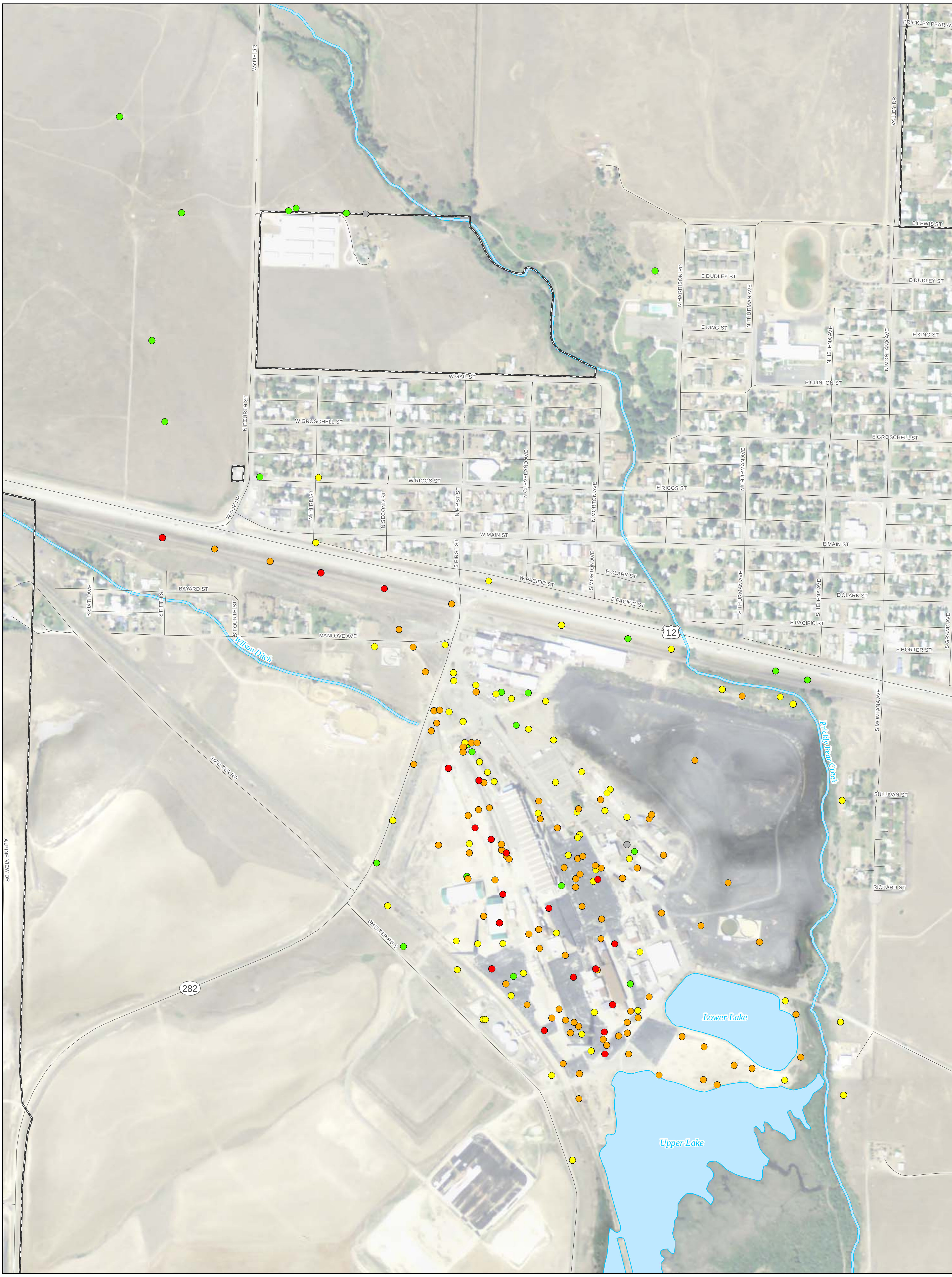

LEGEND

Arsenic Concentrations (mg/kg)

- >2,900
- >290 - 2,900
- >29 - 290
- >2.9 - 29
- >0.29 - 2.9
- <0.29
- Non-Detect

Screen Level Values (See Section 4)

Residential - 0.39 mg/kg

Industrial - 1.6 mg/kg

Groundwater Protection - 0.29 mg/kg

Background - 16.5 mg/kg

All Other Features

East Helena City Limits

Roads

Surface Water Features

MAP NOTES:

Date: April 20, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900

Feet

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FIGURE 6-5b

Arsenic Concentrations in Subsurface Soil (0.5 - 3.0 ft bgs)

Phase II RFI Report

East Helena Facility

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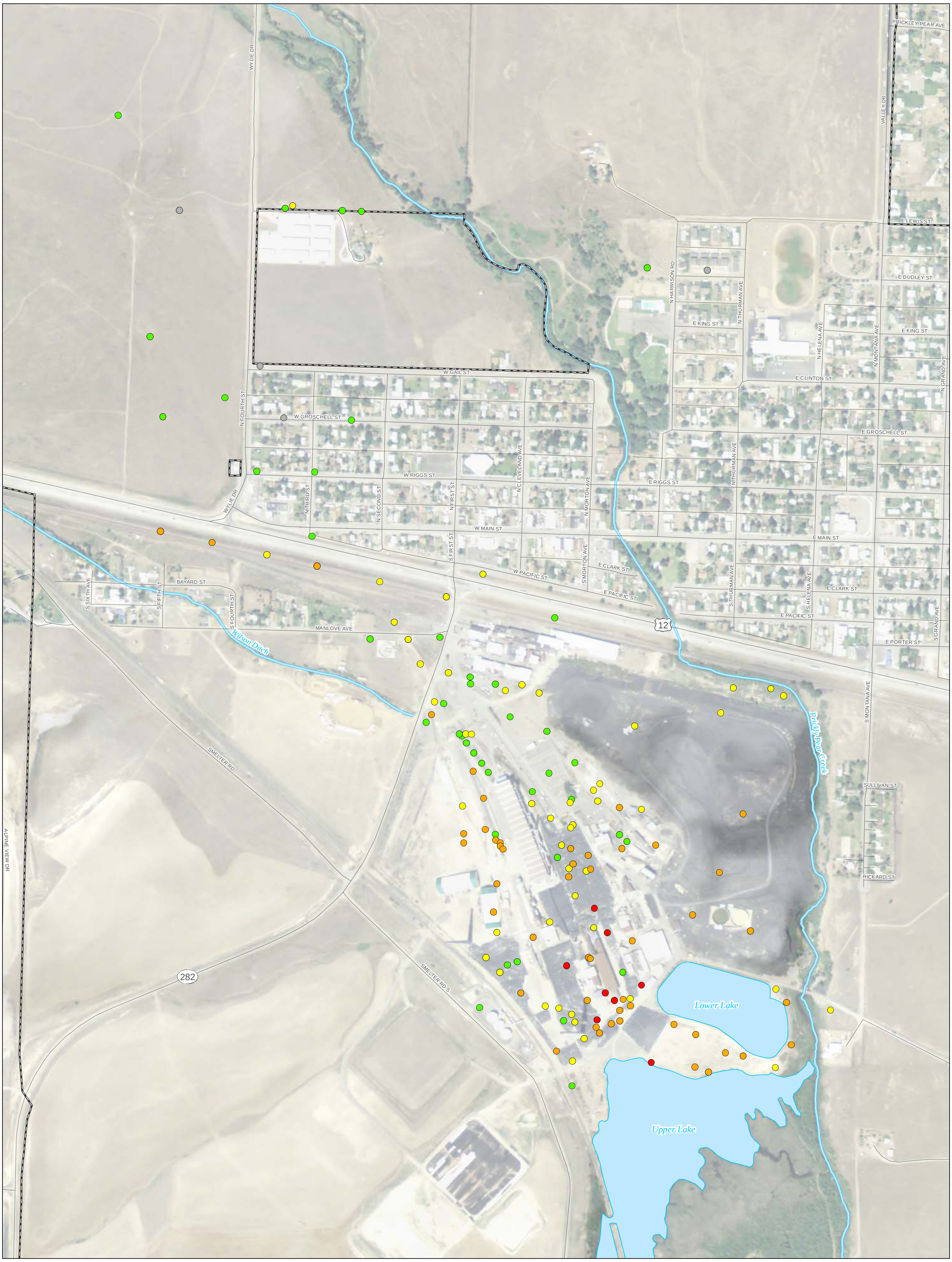

LEGEND

Arsenic Concentrations (mg/kg)

- >2,900
- >290 - 2,900
- >29 - 290
- >2.9 - 29
- >0.29 - 2.9
- <0.29
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 0.39 mg/kg
- Industrial - 1.6 mg/kg
- Groundwater Protection - 0.29 mg/kg
- Background - 16.5 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

FIGURE 6-5c

Arsenic Concentrations in Subsurface Soil
(3.0 - 6.0 ft bgs)

Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.

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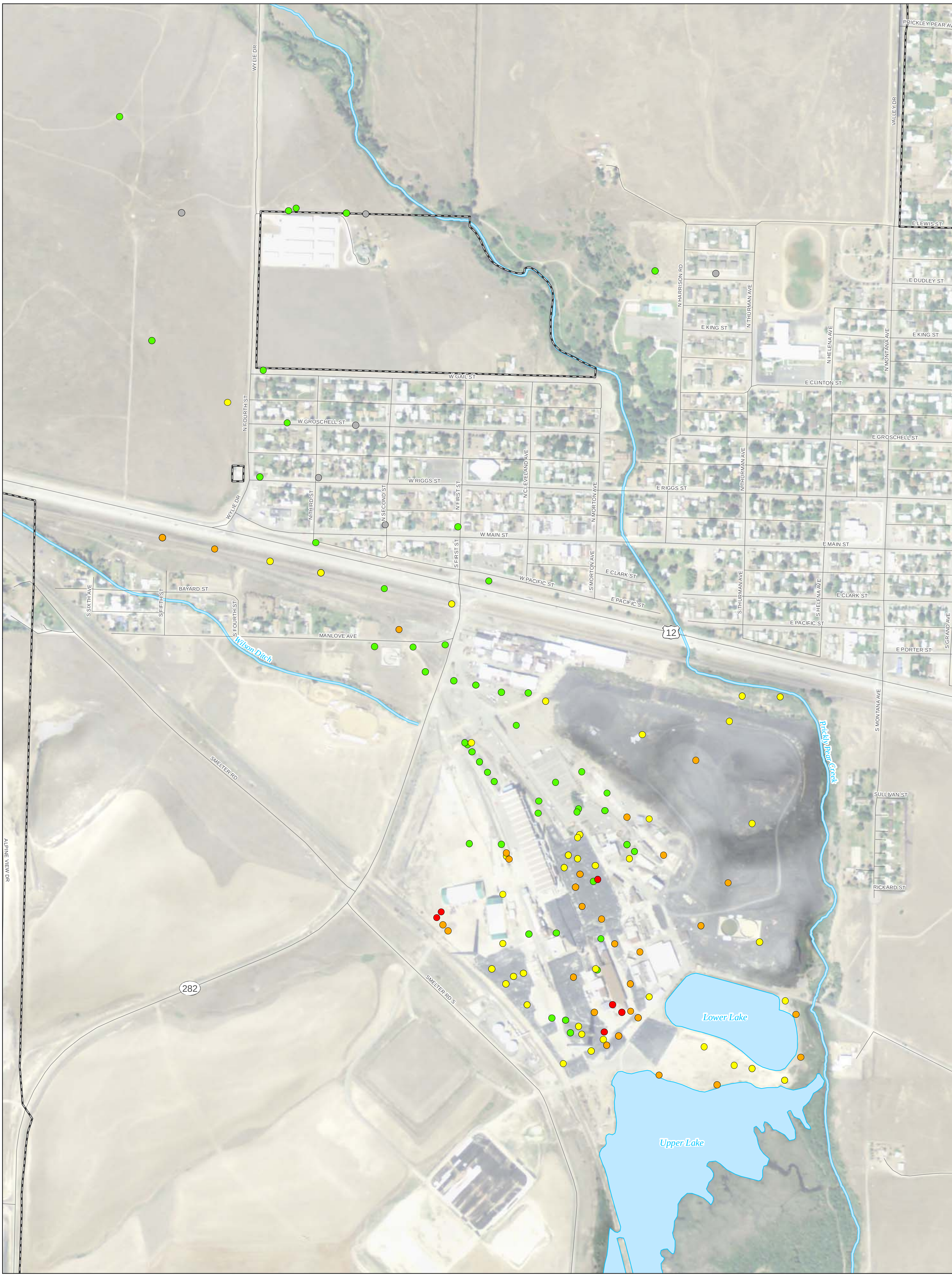

LEGEND

Arsenic Concentrations (mg/kg)

- >2,900
- >290 - 2,900
- >29 - 290
- >2.9 - 29
- >0.29 - 2.9
- <0.29
- Non-Detect

Screen Level Values (See Section 4)

Residential - 0.39 mg/kg

Industrial - 1.6 mg/kg

Groundwater Protection - 0.29 mg/kg

Background - 16.5 mg/kg

All Other Features

East Helena City Limits

Roads

Surface Water Features

MAP NOTES:

Date: April 20, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900

Feet

GSI Water Solutions, Inc.

FIGURE 6-5d

Arsenic Concentrations in Subsurface Soil (6.0 - 10.0 ft bgs)

Phase II RFI Report
East Helena Facility

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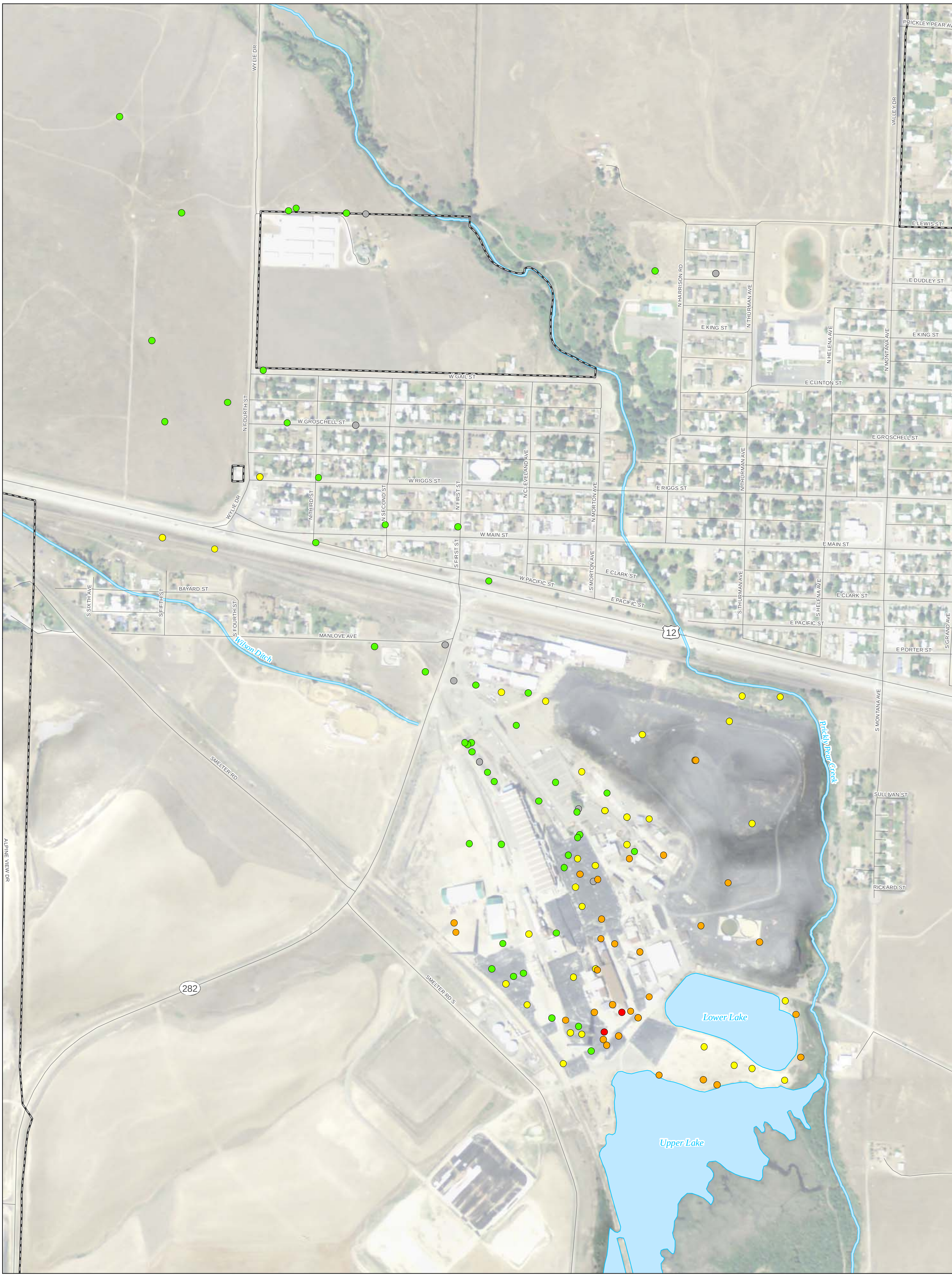

LEGEND

Arsenic Concentrations (mg/kg)

- >2,900
- >290 - 2,900
- >29 - 290
- >2.9 - 29
- >0.29 - 2.9
- <0.29
- Non-Detect

Screen Level Values (See Section 4)

Residential - 0.39 mg/kg
Industrial - 1.6 mg/kg
Groundwater Protection - 0.29 mg/kg
Background - 16.5 mg/kg

All Other Features

East Helena City Limits
Roads
Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

FIGURE 6-5e

Arsenic Concentrations in Subsurface Soil (10.0 - 20.0 ft bgs)

Phase II RFI Report
East Helena Facility

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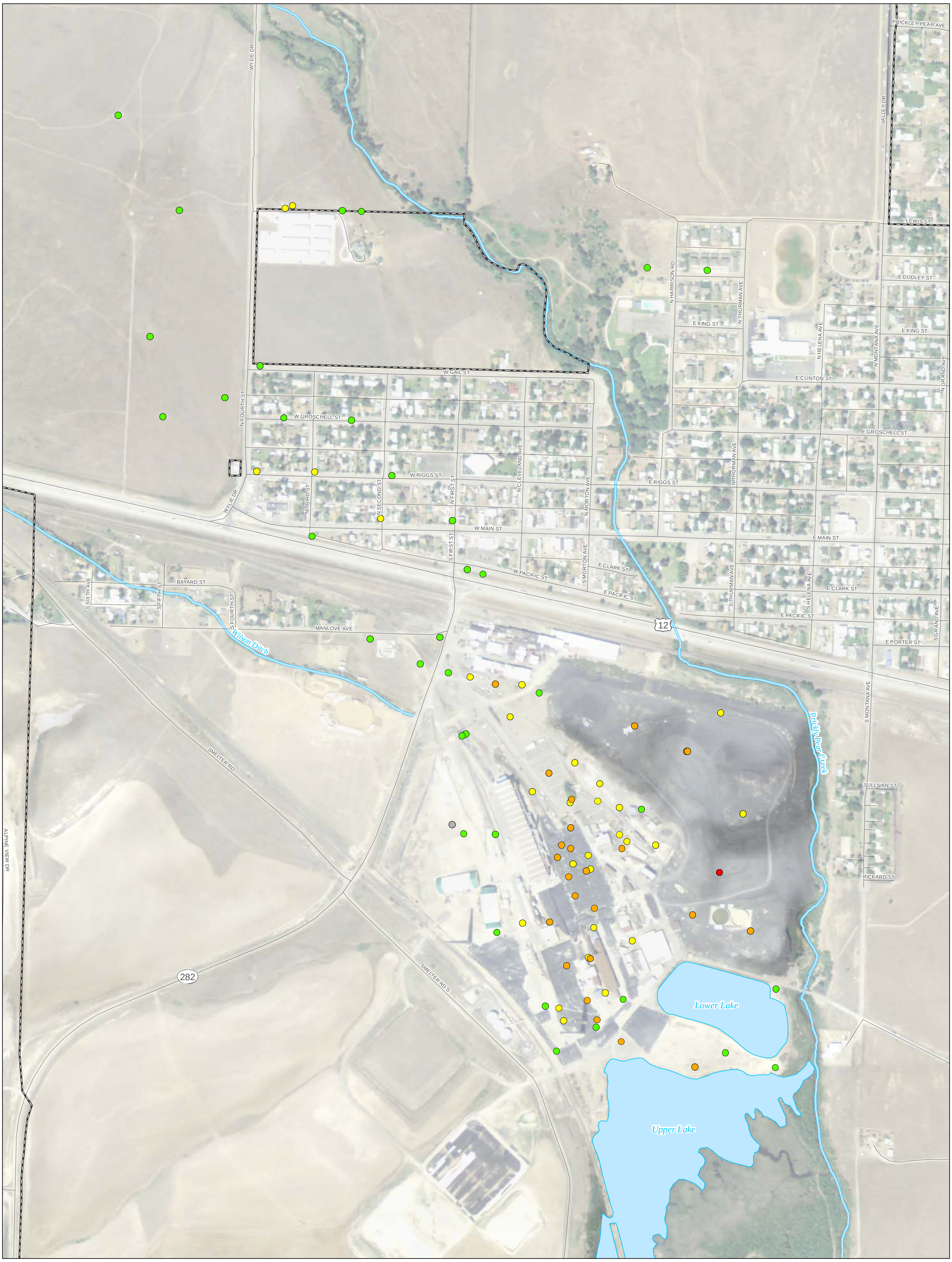


LEGEND

Arsenic Concentrations (mg/kg)

- >2,900
- >290 - 2,900
- >29 - 290
- >2.9 - 29
- >0.29 - 2.9
- <0.29
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 0.39 mg/kg
- Industrial - 1.6 mg/kg
- Groundwater Protection - 0.29 mg/kg
- Background - 16.5 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

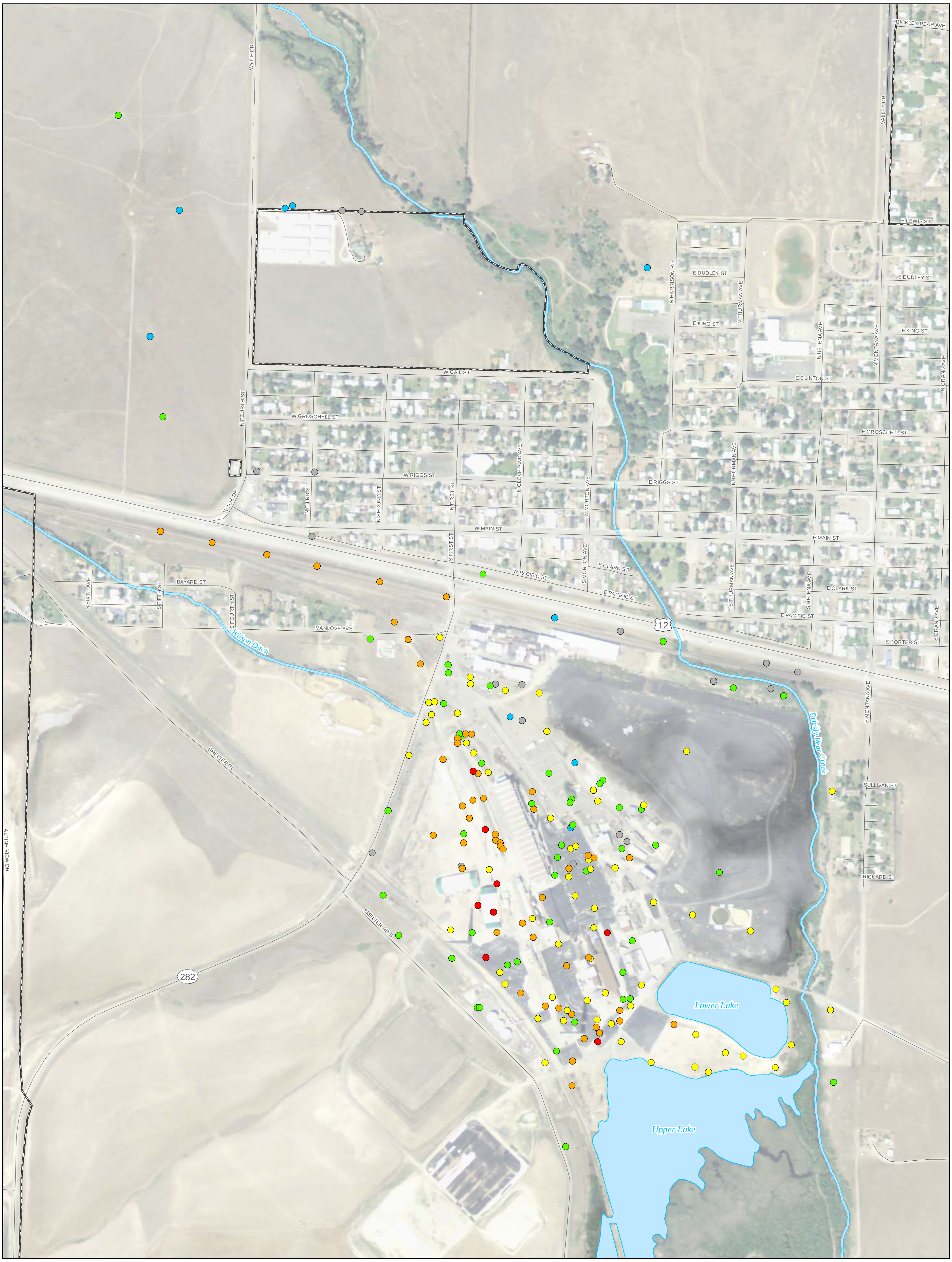
GSI Water Solutions, Inc.

FIGURE 6-5f

Arsenic Concentrations in Subsurface Soil (>20.0 ft bgs)

Phase II RFI Report
East Helena Facility

Revised July 2014



LEGEND

Cadmium Concentrations (mg/kg)
- >3,800
- >380 - 3,800
- >38 - 380
- >3.8 - 38
- >0.38 - 3.8
- <0.38
- Non-Detect

Screen Level Values (See Section 4)
- Residential - 70 mg/kg
- Industrial - 800 mg/kg
- Groundwater Protection - 0.38 mg/kg
- Background - 0.24 mg/kg

All Other Features
- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

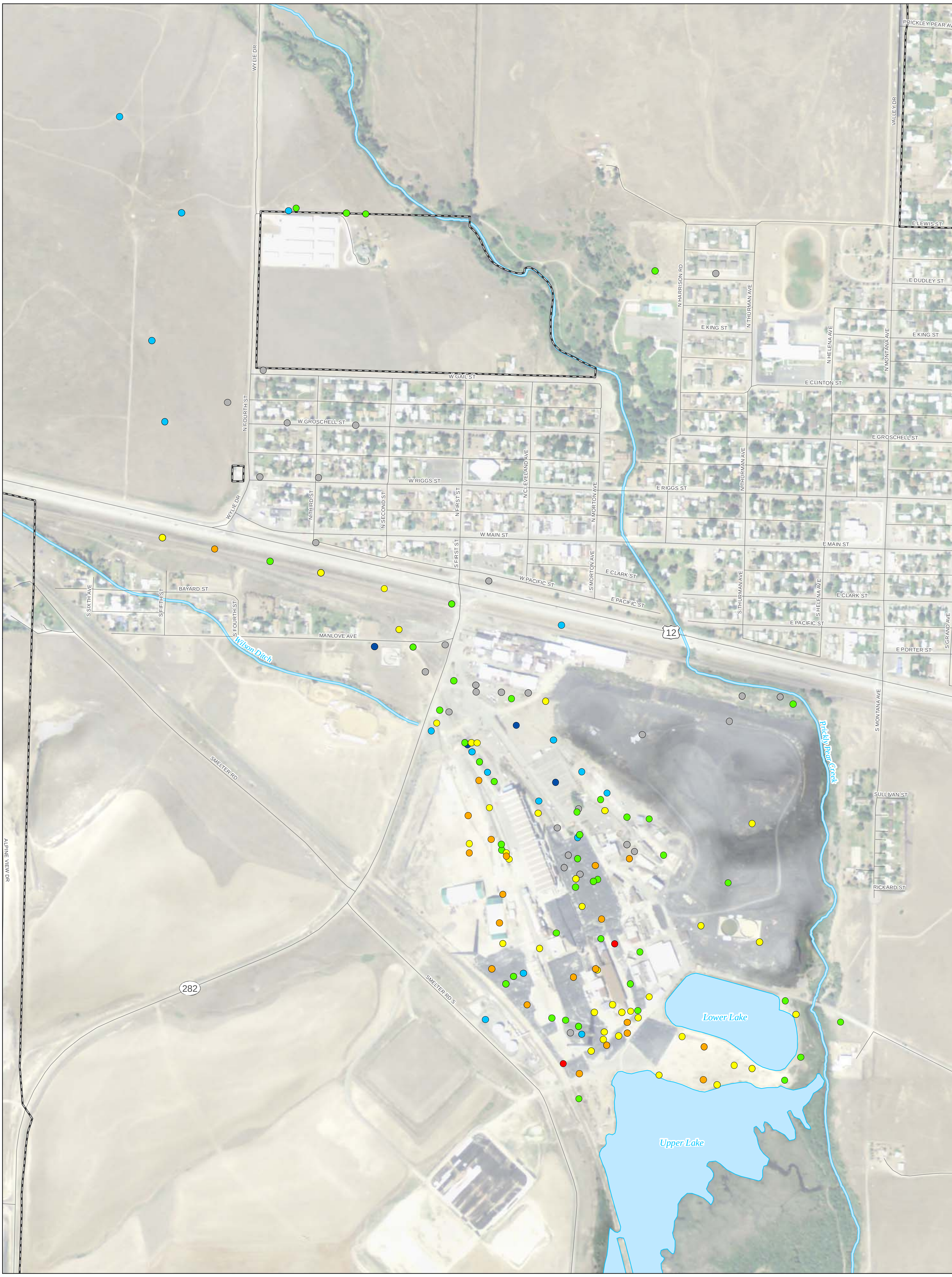
FIGURE 6-6b

Cadmium Concentrations in Subsurface Soil (0.5 - 3.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-6b_Cd_in_Subsurface_Sed_A.mxd, Date: April 20, 2011 3:48:26 PM

Revised July 2014



LEGEND

Cadmium Concentrations (mg/kg)

- >3,800
- >380 - 3,800
- >38 - 380
- >3.8 - 38
- >0.38 - 3.8
- <0.38
- Non-Detect

Screen Level Values (See Section 4)

Residential - 70 mg/kg

Industrial - 800 mg/kg

Groundwater Protection - 0.38 mg/kg

Background - 0.24 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:

Date: April 20, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900

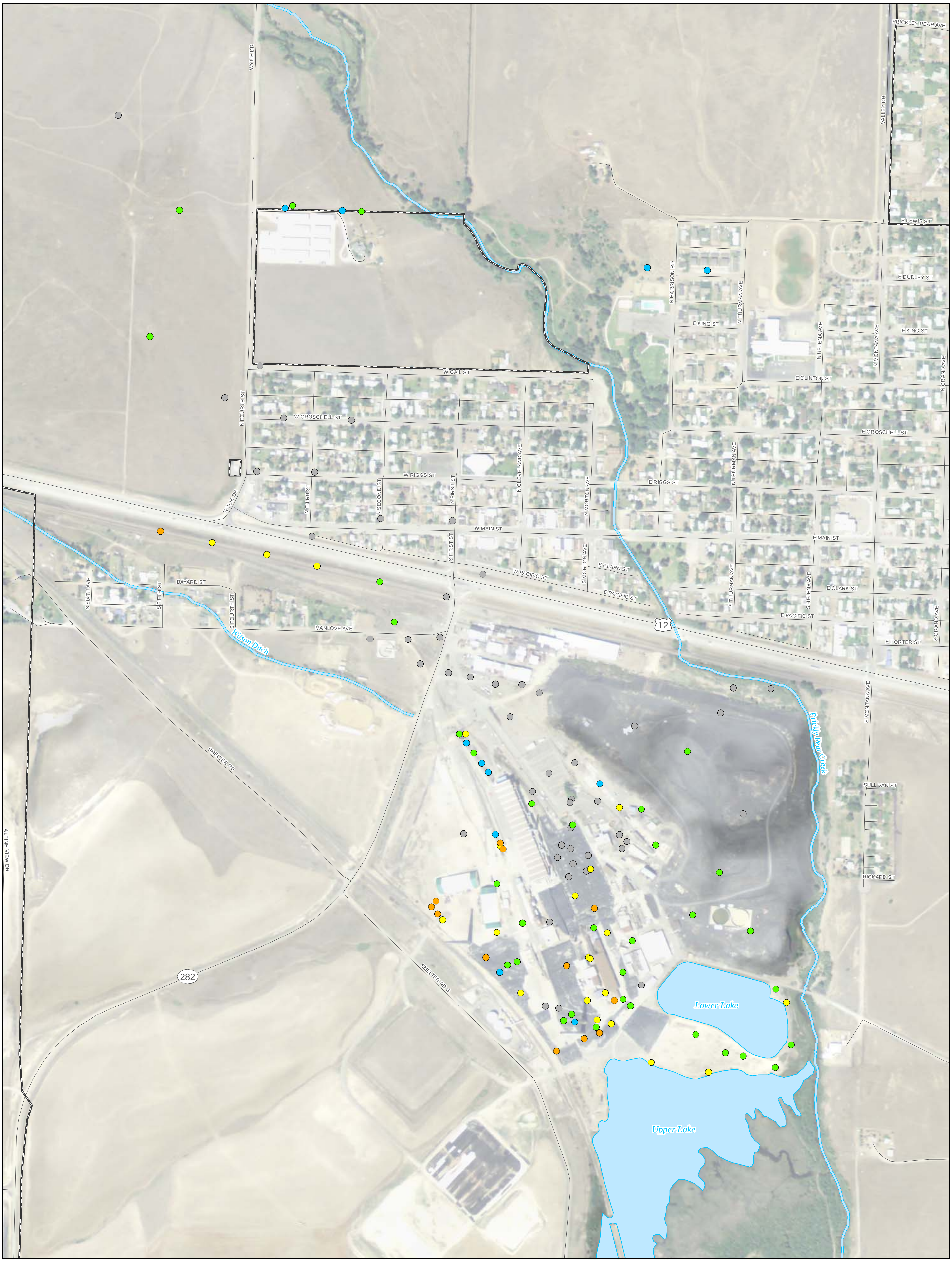
Feet

FIGURE 6-6c

Cadmium Concentrations in Subsurface Soil (3.0 - 6.0 ft bgs)

Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.



LEGEND

Cadmium Concentrations (mg/kg)

- >3,800
- >380 - 3,800
- >38 - 380
- >3.8 - 38
- >0.38 - 3.8
- <0.38
- Non-Detect

Screen Level Values (See Section 4)

Residential - 70 mg/kg
Industrial - 800 mg/kg
Groundwater Protection - 0.38 mg/kg
Background - 0.24 mg/kg

All Other Features

East Helena City Limits
Roads
Surface Water Features

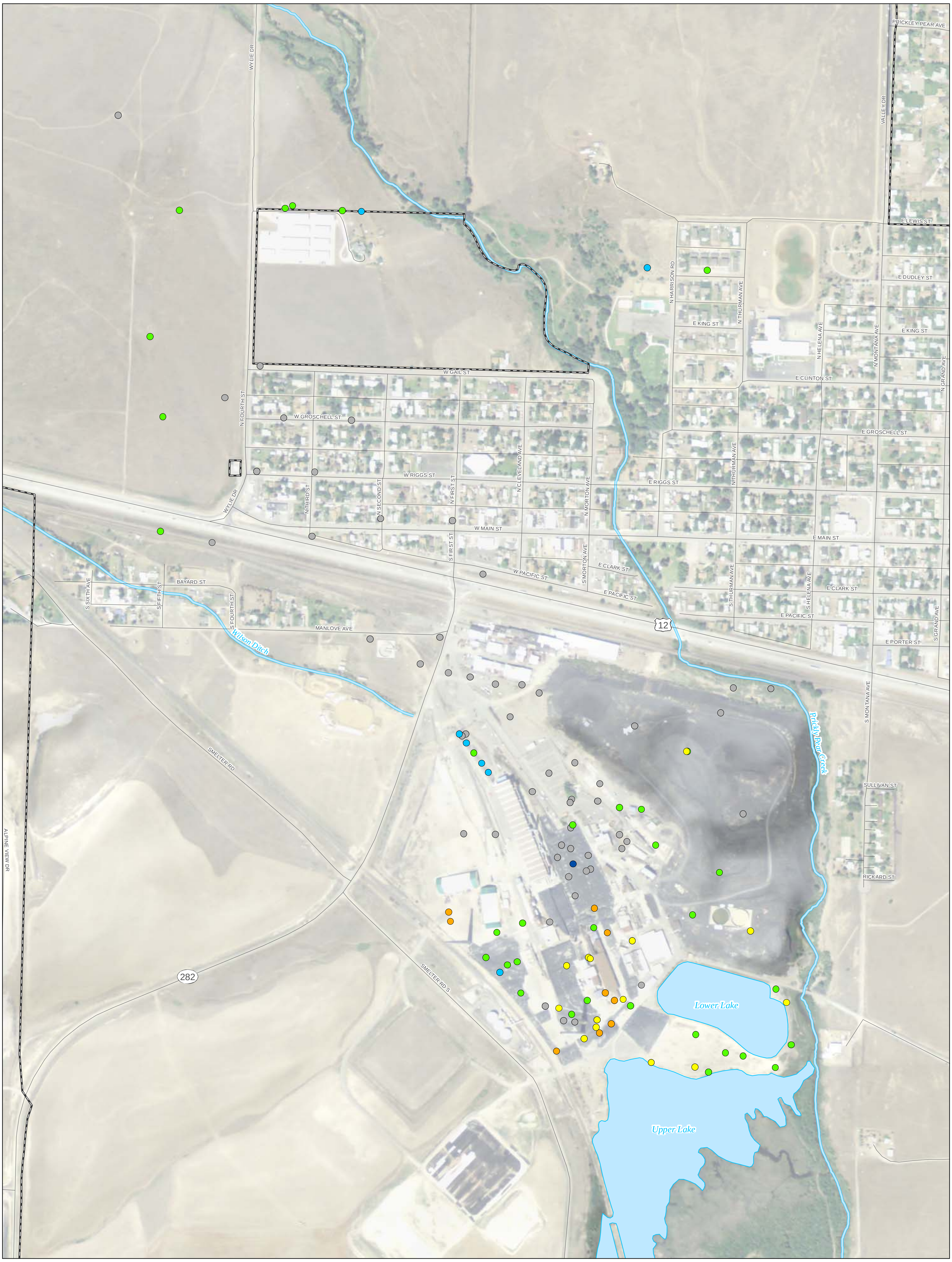
MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

FIGURE 6-6d

Cadmium Concentrations in Subsurface Soil
(6.0 - 10.0 ft bgs)

Phase II RFI Report
East Helena Facility

Revised July 2014



LEGEND

Cadmium Concentrations (mg/kg)

- >3,800
- >380 - 3,800
- >38 - 380
- >3.8 - 38
- >0.38 - 3.8
- <0.38
- Non-Detect

Screen Level Values (See Section 4)

Residential - 70 mg/kg

Industrial - 800 mg/kg

Groundwater Protection - 0.38 mg/kg

Background - 0.24 mg/kg

All Other Features

East Helena City Limits

Roads

Surface Water Features

MAP NOTES:

Date: April 20, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900

Feet

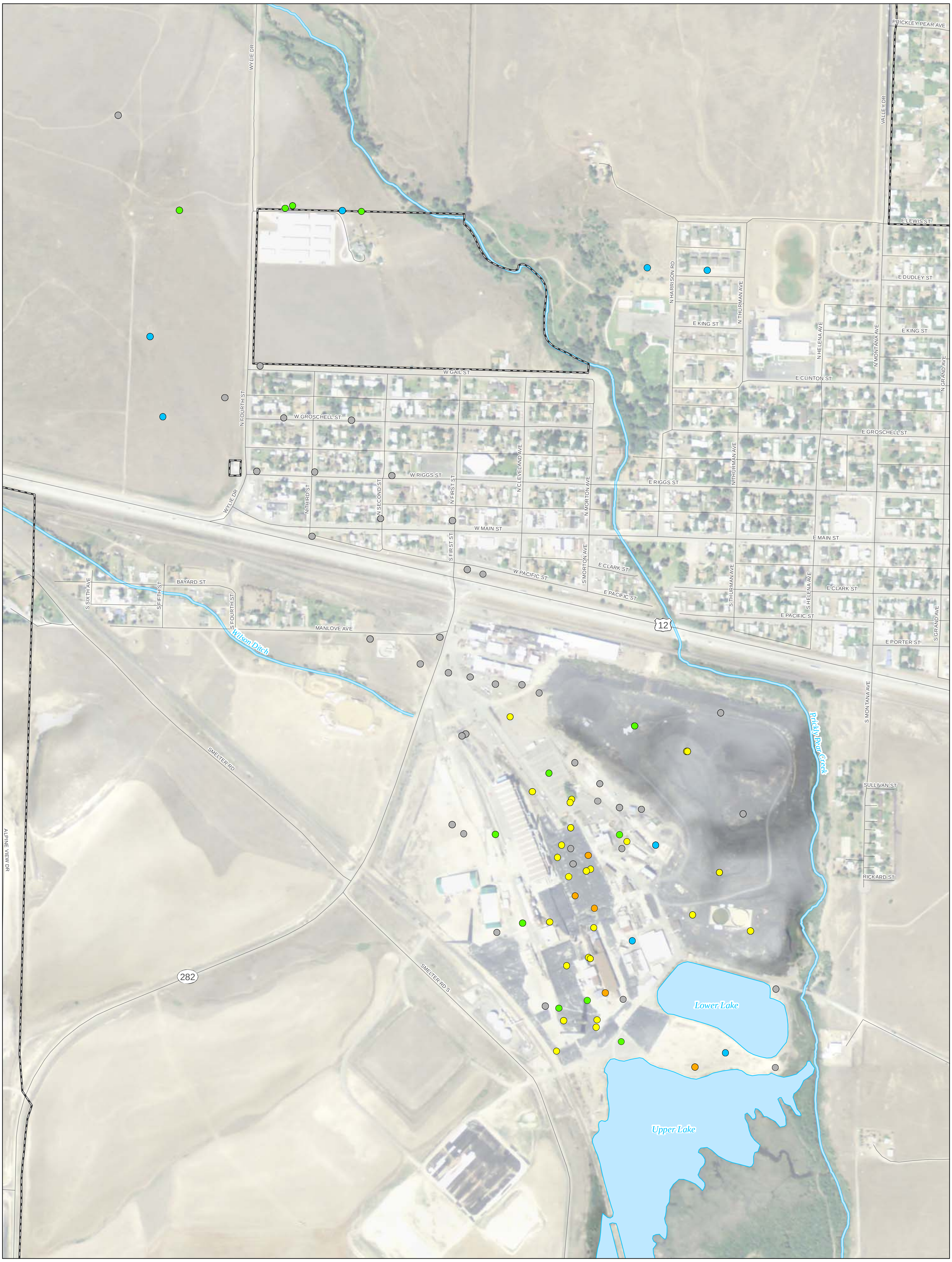
GSI Water Solutions, Inc.

FIGURE 6-6e

Cadmium Concentrations in Subsurface Soil (10.0 - 20.0 ft bgs)

Phase II RFI Report
East Helena Facility

Revised July 2014



LEGEND

Cadmium Concentrations (mg/kg)

- >3,800
- >380 - 3,800
- >38 - 380
- >3.8 - 38
- >0.38 - 3.8
- <0.38
- Non-Detect

Screen Level Values (See Section 4)

Residential - 70 mg/kg
Industrial - 800 mg/kg
Groundwater Protection - 0.38 mg/kg
Background - 0.24 mg/kg

All Other Features

East Helena City Limits
Roads
Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

FIGURE 6-6f

Cadmium Concentrations in Subsurface Soil (>20.0 ft bgs)

Phase II RFI Report
East Helena Facility

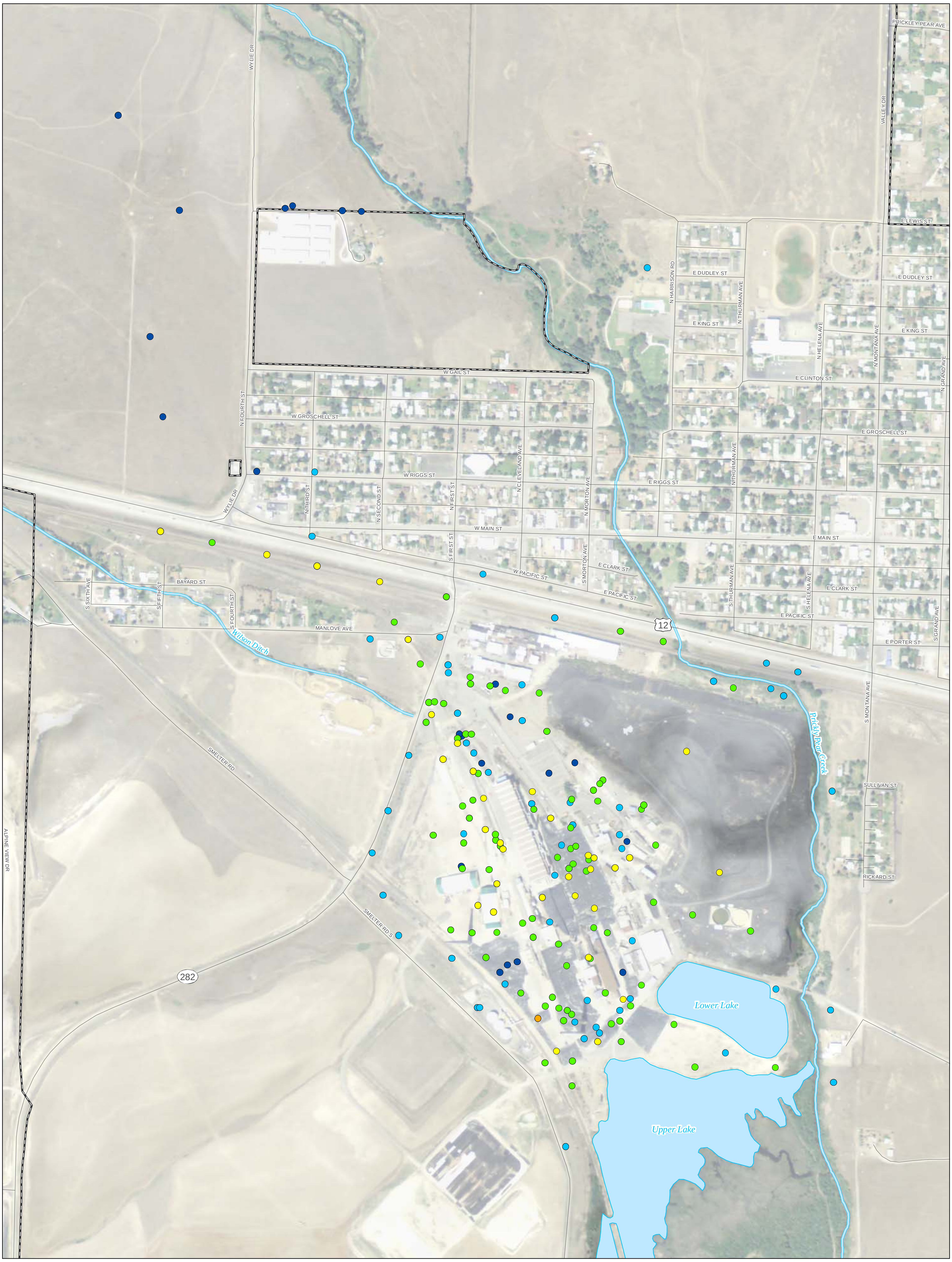
N

0 300 600 900
Feet

GSI Water Solutions, Inc.

Revised July 2014

ES081313034307PDX 486085.46.08.01 Rv2 07-29-14 lh



LEGEND

Copper Concentrations (mg/kg)

- >460,000
- >46,000 - 460,000
- >4,600 - 46,000
- >460 - 4,600
- >46 - 460
- <46
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 3,100 mg/kg
- Industrial - 41,000 mg/kg
- Groundwater Protection - 46 mg/kg
- Background - 16.3 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

FIGURE 6-8b

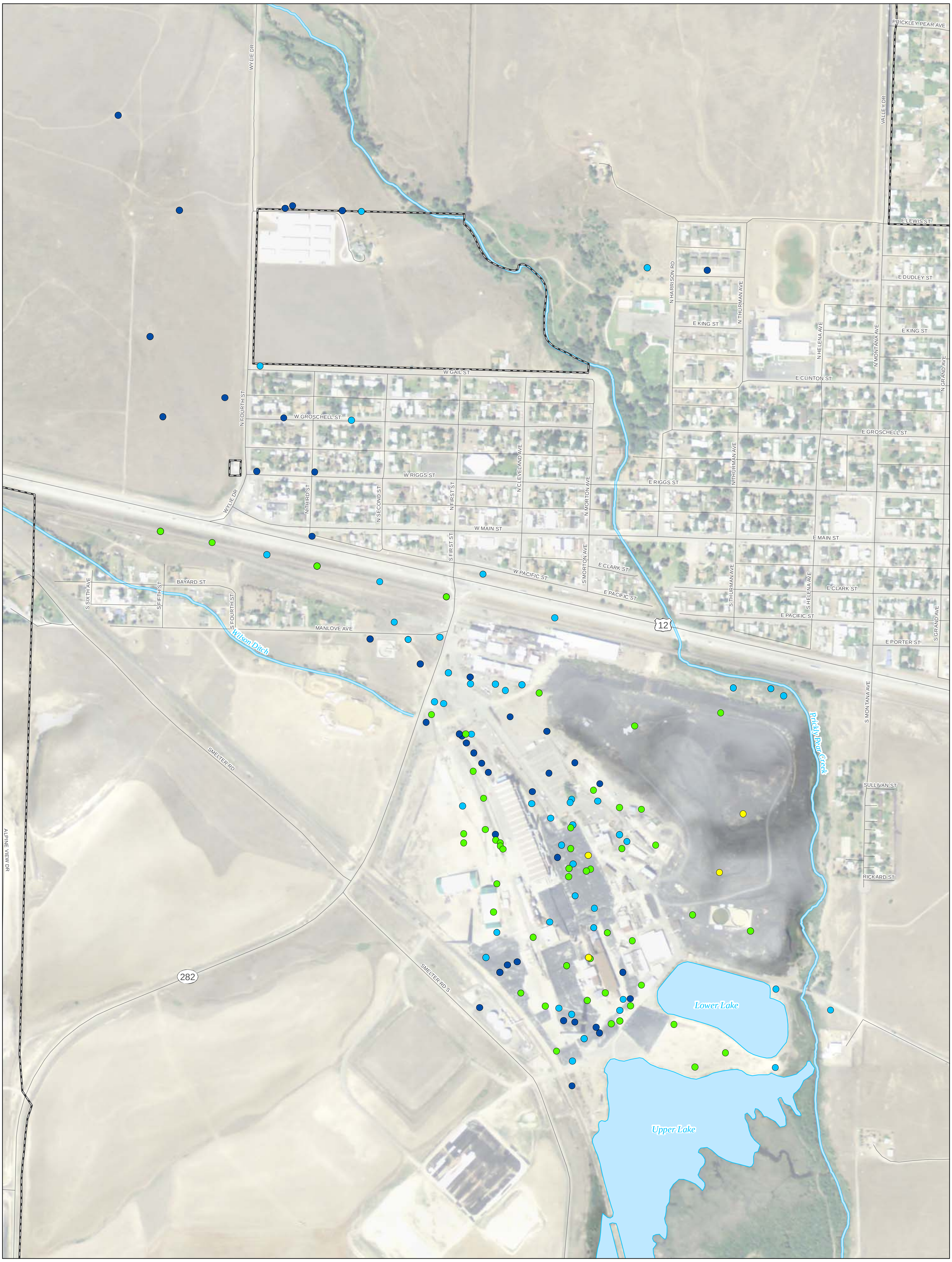
Copper Concentrations in Subsurface Soil (0.5 - 3.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-8b_Cu_in_Subsurface_Sed_A.mxd, Date: April 20, 2011 4:31:17 PM

Revised July 2014

ES081313034307PDX 486085.46.08.01 Rv2 07-29-14 lh



LEGEND

Copper Concentrations (mg/kg)

- >460,000
- >46,000 - 460,000
- >4,600 - 46,000
- >460 - 4,600
- >46 - 460
- <46
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 3,100 mg/kg
- Industrial - 41,000 mg/kg
- Groundwater Protection - 46 mg/kg
- Background - 16.3 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

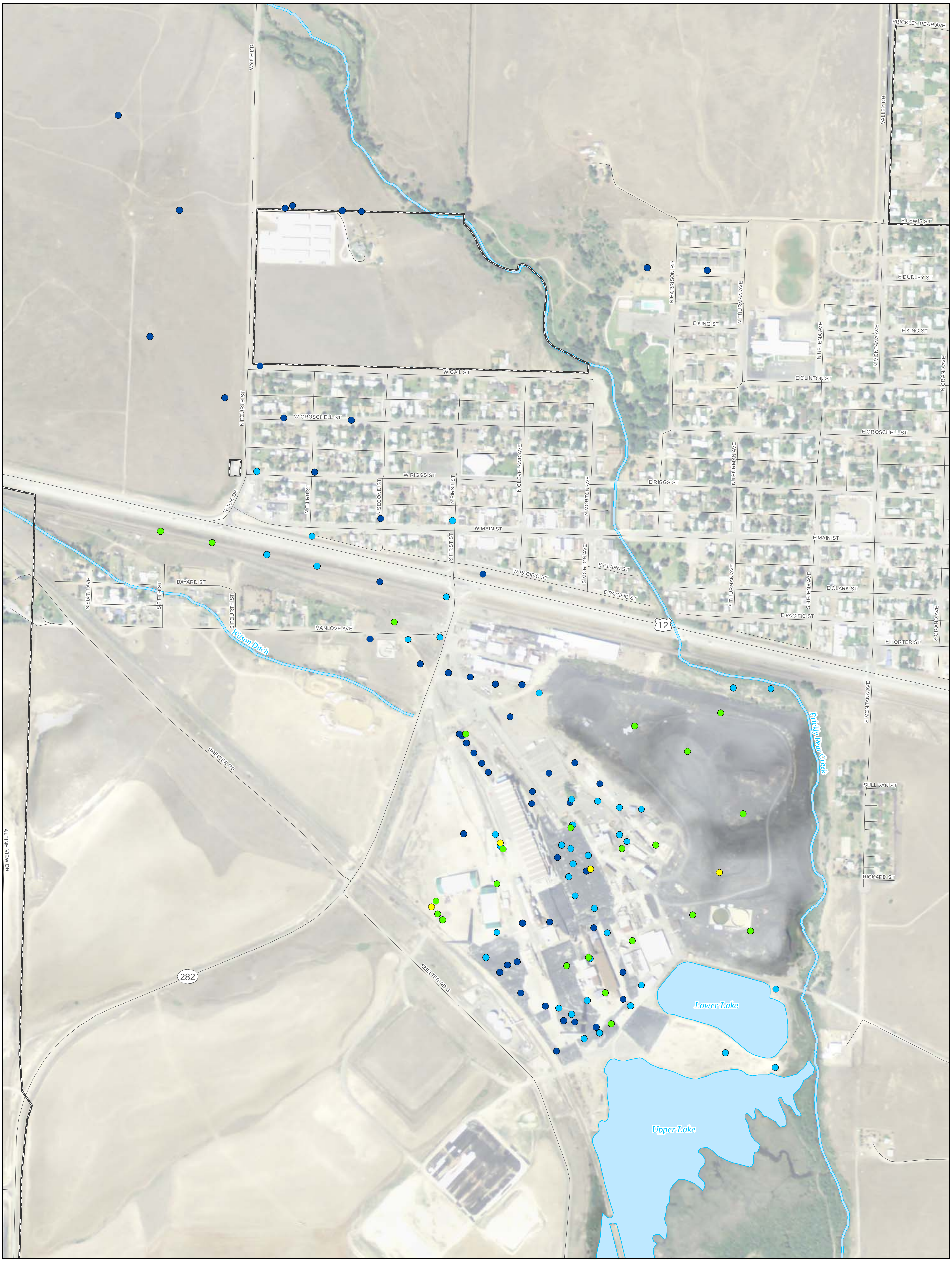
FIGURE 6-8c

Copper Concentrations in Subsurface Soil (3.0 - 6.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-8c_Cu_in_Subsurface_Sed_B.mxd, Date: April 20, 2011 4:44:11 PM

Revised July 2014



LEGEND

Copper Concentrations (mg/kg)

- >460,000
- >46,000 - 460,000
- >4,600 - 46,000
- >460 - 4,600
- >46 - 460
- <46
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 3,100 mg/kg
- Industrial - 41,000 mg/kg
- Groundwater Protection - 46 mg/kg
- Background - 16.3 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

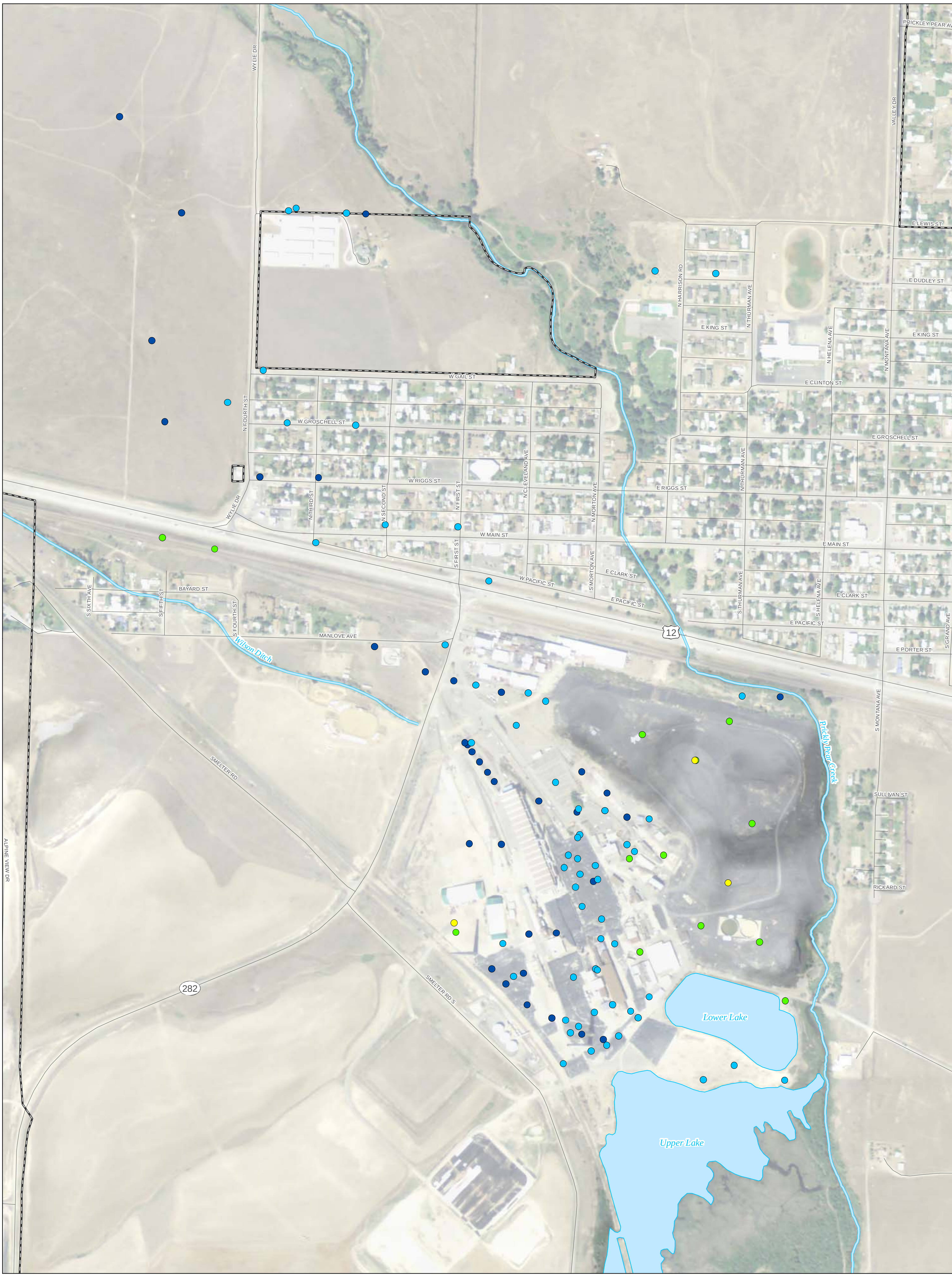
FIGURE 6-8d

Copper Concentrations in Subsurface Soil (6.0 - 10.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-8d_Cu_in_Subsurface_Sed_C.mxd, Date: April 20, 2011 4:46:38 PM

Revised July 2014



LEGEND

Copper Concentrations (mg/kg)

- >460,000
- >46,000 - 460,000
- >4,600 - 46,000
- >460 - 4,600
- >46 - 460
- <46
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 3,100 mg/kg
- Industrial - 41,000 mg/kg
- Groundwater Protection - 46 mg/kg
- Background - 16.3 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

FIGURE 6-8e

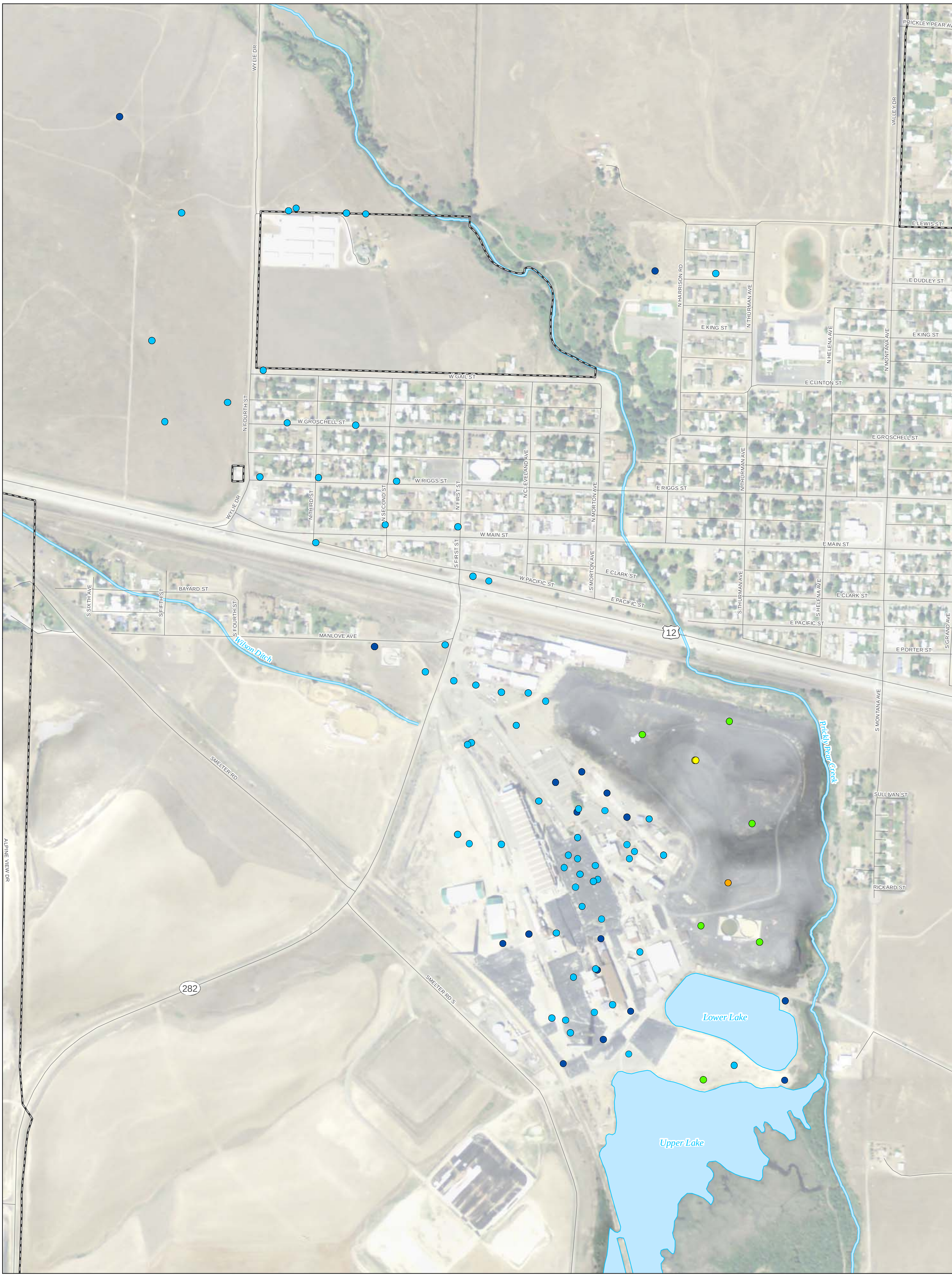
Copper Concentrations in Subsurface Soil (10.0 - 20.0 ft bgs)

Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.

Revised July 2014

ES081313034307PDX 486085.46.08.01 Rv2 07-29-14 lh



LEGEND

Copper Concentrations (mg/kg)

- >460,000
- >46,000 - 460,000
- >4,600 - 46,000
- >460 - 4,600
- >46 - 460
- <46
- Non-Detect

Screen Level Values (See Section 4)

Residential - 3,100 mg/kg

Industrial - 41,000 mg/kg

Groundwater Protection - 46 mg/kg

Background - 16.3 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

FIGURE 6-8f

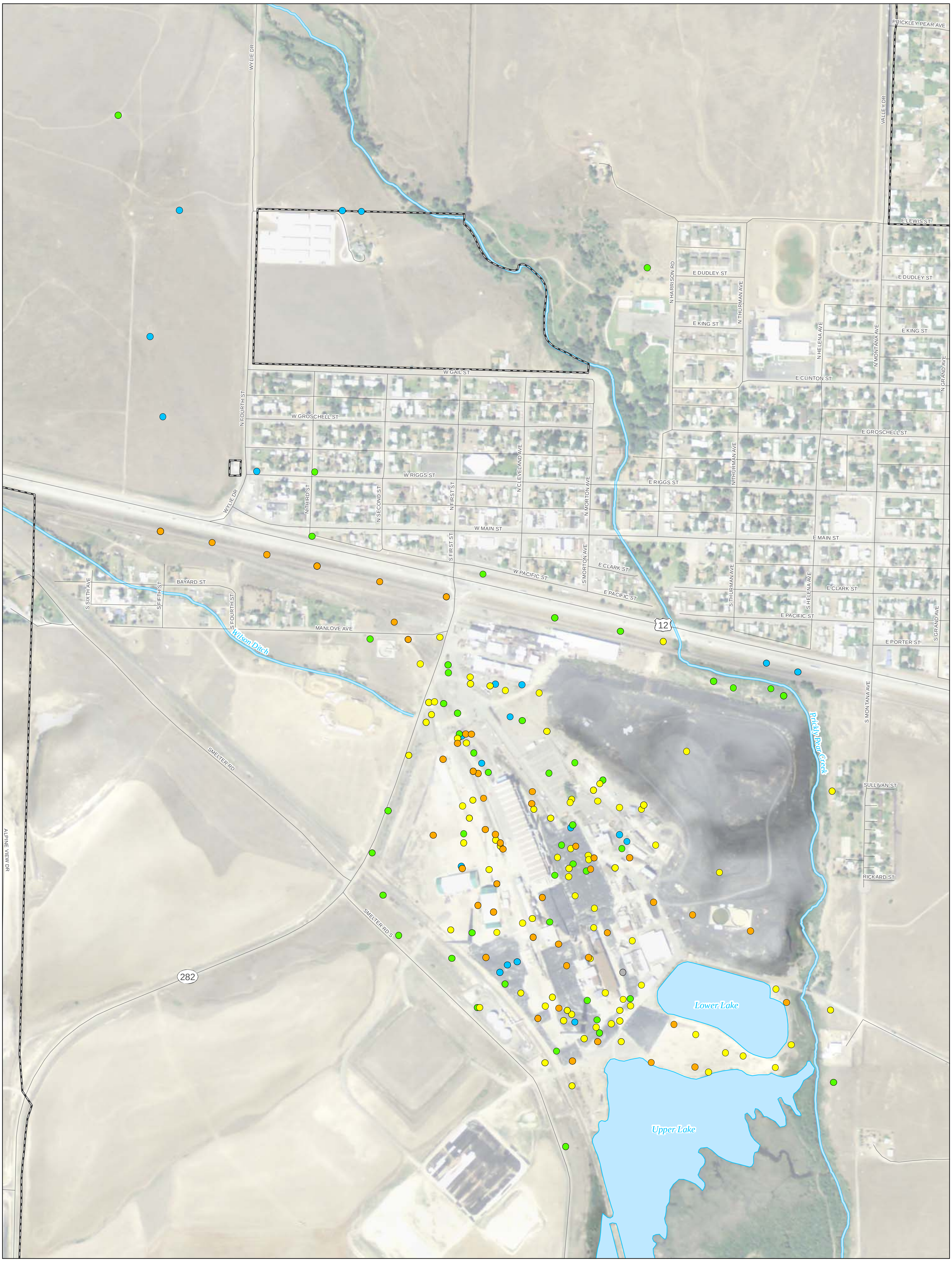
Copper Concentrations in Subsurface Soil (>20.0 ft bgs)

Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-8f_Cu_in_Subsurface_Sed_E.mxd, Date: April 20, 2011 4:50:27 PM

Revised July 2014



LEGEND

Lead Concentrations (mg/kg)

- >140,000
- >14,000 - 140,000
- >1,400 - 14,000
- >140 - 1,400
- >14 - 140
- <14
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 400 mg/kg
- Industrial - 800 mg/kg
- Groundwater Protection - 14 mg/kg
- Background - 11.6 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

FIGURE 6-10b

Lead Concentrations in Subsurface Soil (0.5 - 3.0 ft bgs)

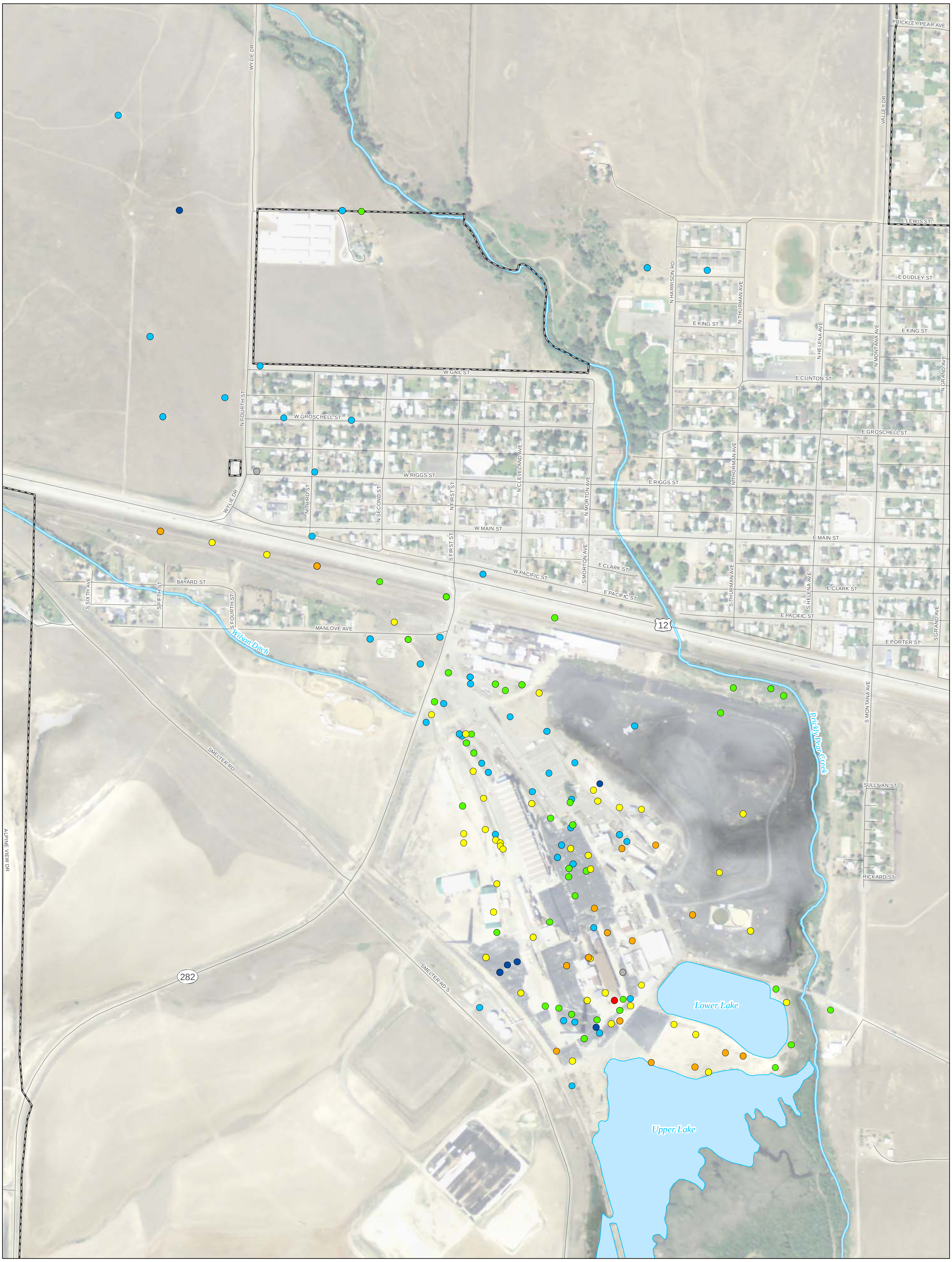
Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-10b_Pb_in_Subsurface_Sed_A.mxd, Date: April 20, 2011 5:37:47 PM

Revised July 2014

ES081313034307PDX 486085.46.08.01 Rv2 07-29-14 lh



LEGEND

Lead Concentrations (mg/kg)

- >140,000
- >14,000 - 140,000
- >1,400 - 14,000
- >140 - 1,400
- >14 - 140
- <14
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 400 mg/kg
- Industrial - 800 mg/kg
- Groundwater Protection - 14 mg/kg
- Background - 11.6 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

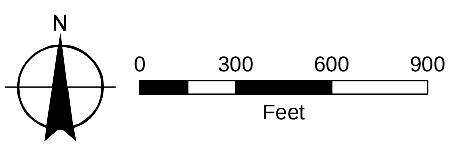


FIGURE 6-10c

Lead Concentrations in Subsurface Soil (3.0 - 6.0 ft bgs)

Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-10c_Pb_in_Subsurface_Sed_B.mxd, Date: April 20, 2011 5:40:32 PM

Revised July 2014

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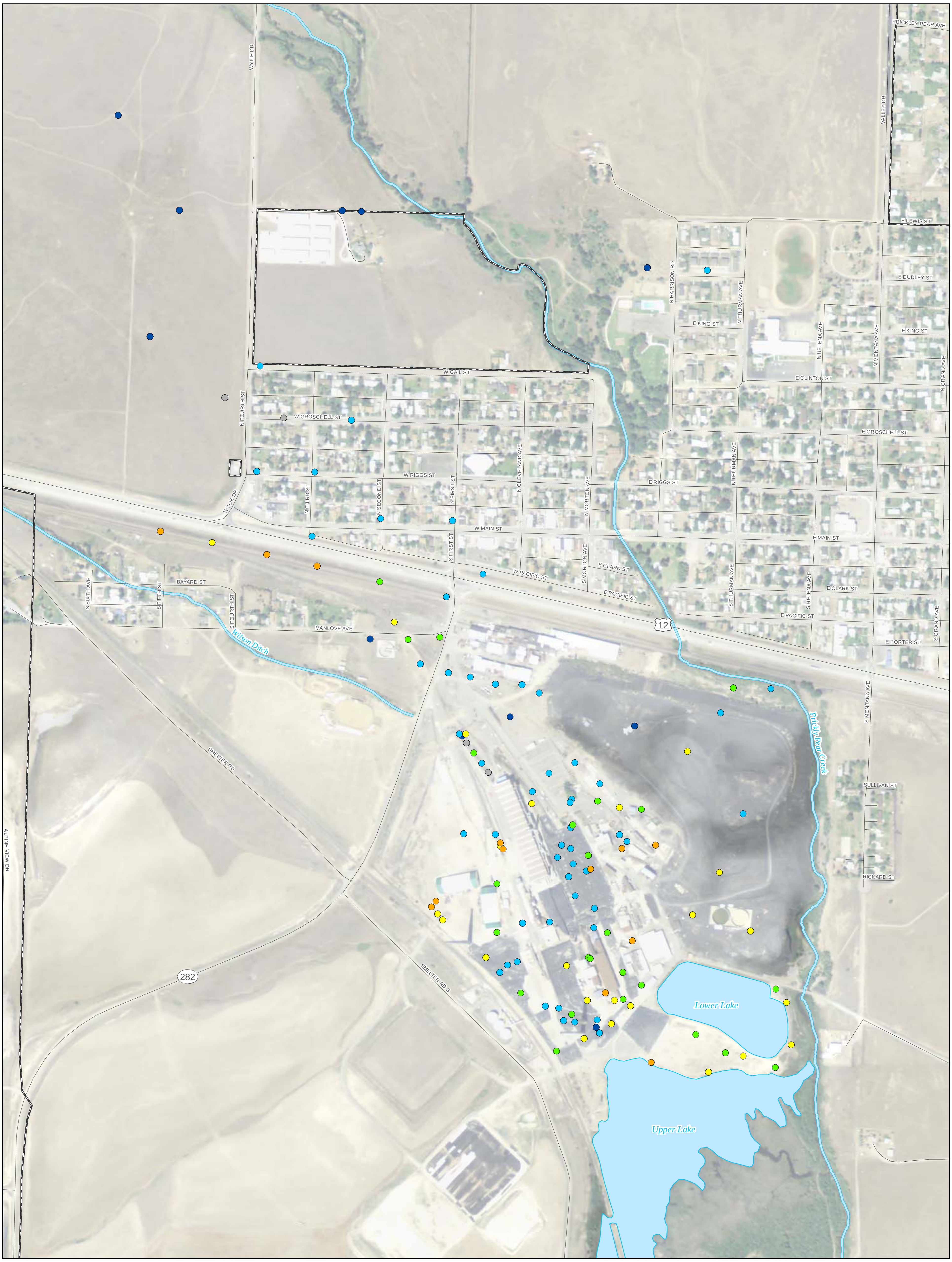


LEGEND

Lead Concentrations (mg/kg)

- >140,000
- >14,000 - 140,000
- >1,400 - 14,000
- >140 - 1,400
- >14 - 140
- <14
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 400 mg/kg
- Industrial - 800 mg/kg
- Groundwater Protection - 14 mg/kg
- Background - 11.6 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

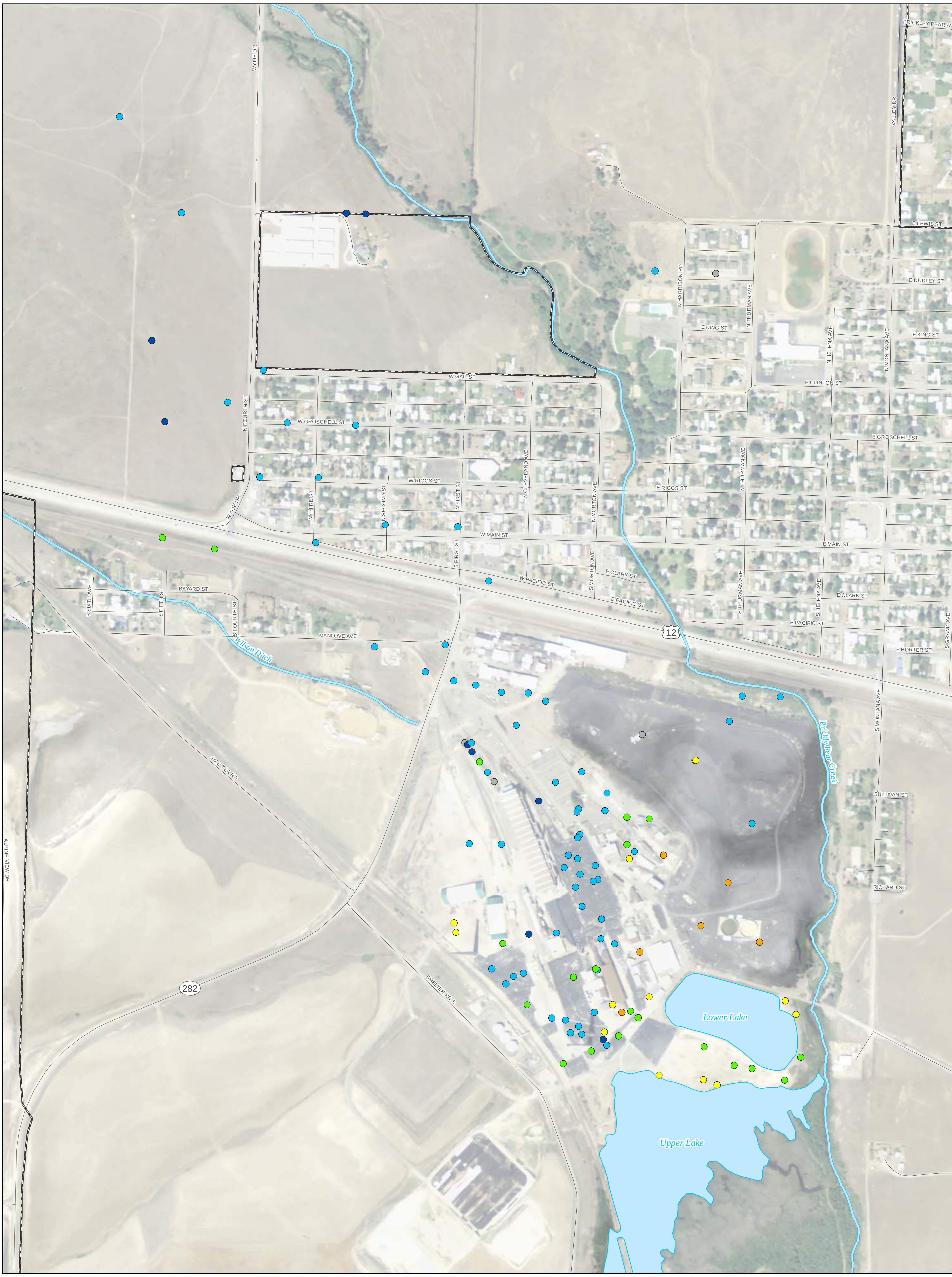
FIGURE 6-10d

Lead Concentrations in Subsurface Soil
(6.0 - 10.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-10d_Pb_in_Subsurface_Sed_C.mxd, Date: April 20, 2011 5:42:54 PM

Revised July 2014



LEGEND

Lead Concentrations (mg/kg)

- >140,000
- >14,000 - 140,000
- >1,400 - 14,000
- >140 - 1,400
- >14 - 140
- <14
- Non-Detect

Screen Level Values (See Section 4)

Residential - 400 mg/kg

Industrial - 800 mg/kg

Groundwater Protection - 14 mg/kg

Background - 11.6 mg/kg

All Other Features

East Helena City Limits

Roads

Surface Water Features

MAP NOTES:

Date: April 20, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900

Feet

GSI Water Solutions, Inc.

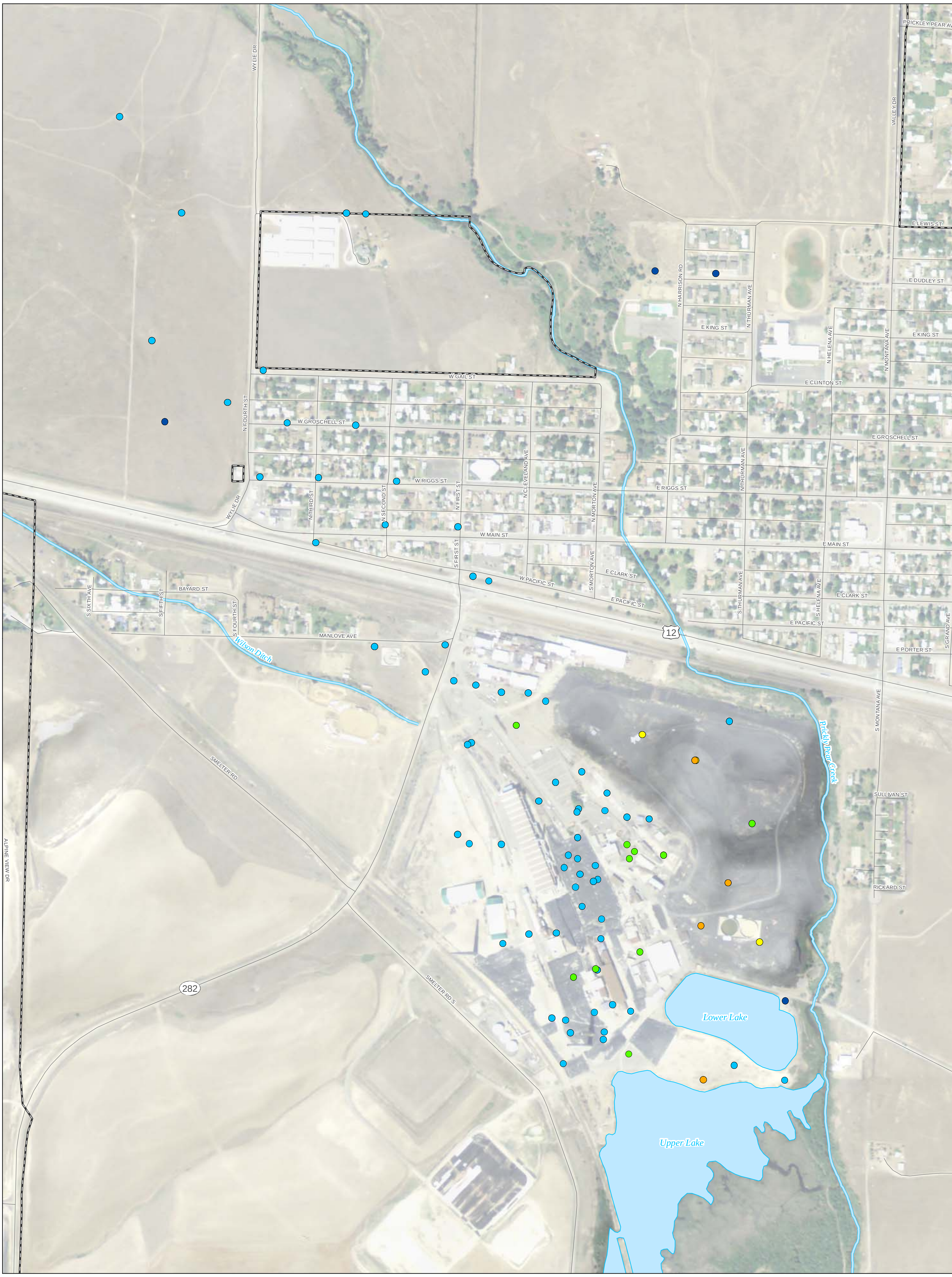
FIGURE 6-10e

Lead Concentrations in Subsurface Soil (10.0 - 20.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-10e_Pb_in_Subsurface_Sed_D.mxd, Date: April 20, 2011 5:45:16 PM

Revised July 2014



LEGEND

Lead Concentrations (mg/kg)

- >140,000
- >14,000 - 140,000
- >1,400 - 14,000
- >140 - 1,400
- >14 - 140
- <14
- Non-Detect

Screen Level Values (See Section 4)

Residential - 400 mg/kg

Industrial - 800 mg/kg

Groundwater Protection - 14 mg/kg

Background - 11.6 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:

Date: April 20, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900

Feet

FIGURE 6-10f

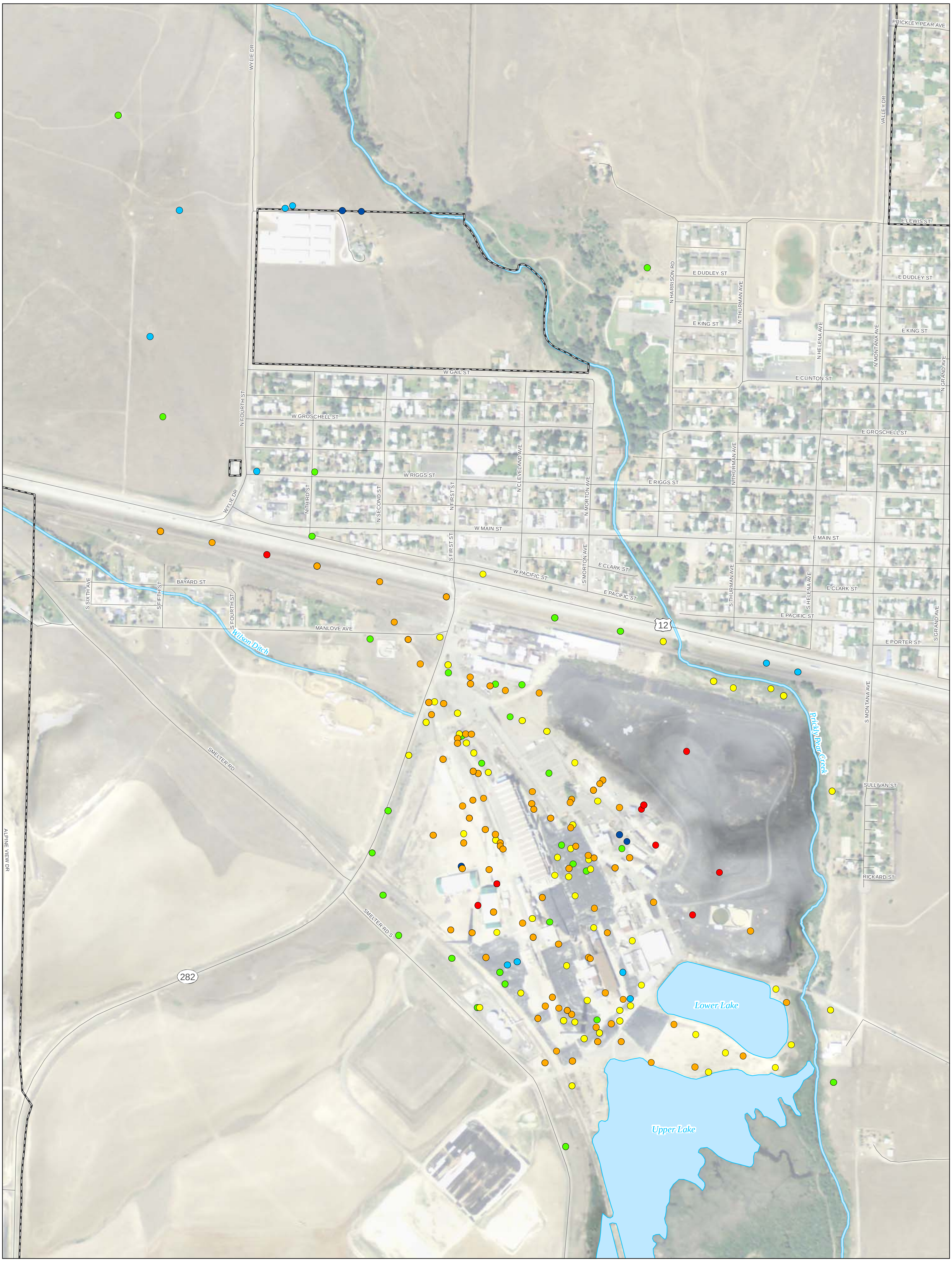
Lead Concentrations in Subsurface Soil (>20.0 ft bgs)

Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-10f_Pb_in_Subsurface_Sed_E.mxd, Date: April 20, 2011 5:47:20 PM

Revised July 2014



LEGEND

Zinc Concentrations (mg/kg)

- >46,900
- >4,690 - 46,900
- >469 - 4,690
- >93.8 - 469
- >46.9 - 93.8
- <46.9
- Non-Detect

Screen Level Values (See Section 4)

Residential - 23,000 mg/kg
Industrial - 310,000 mg/kg
Groundwater Protection - NA
Background - 46.9 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

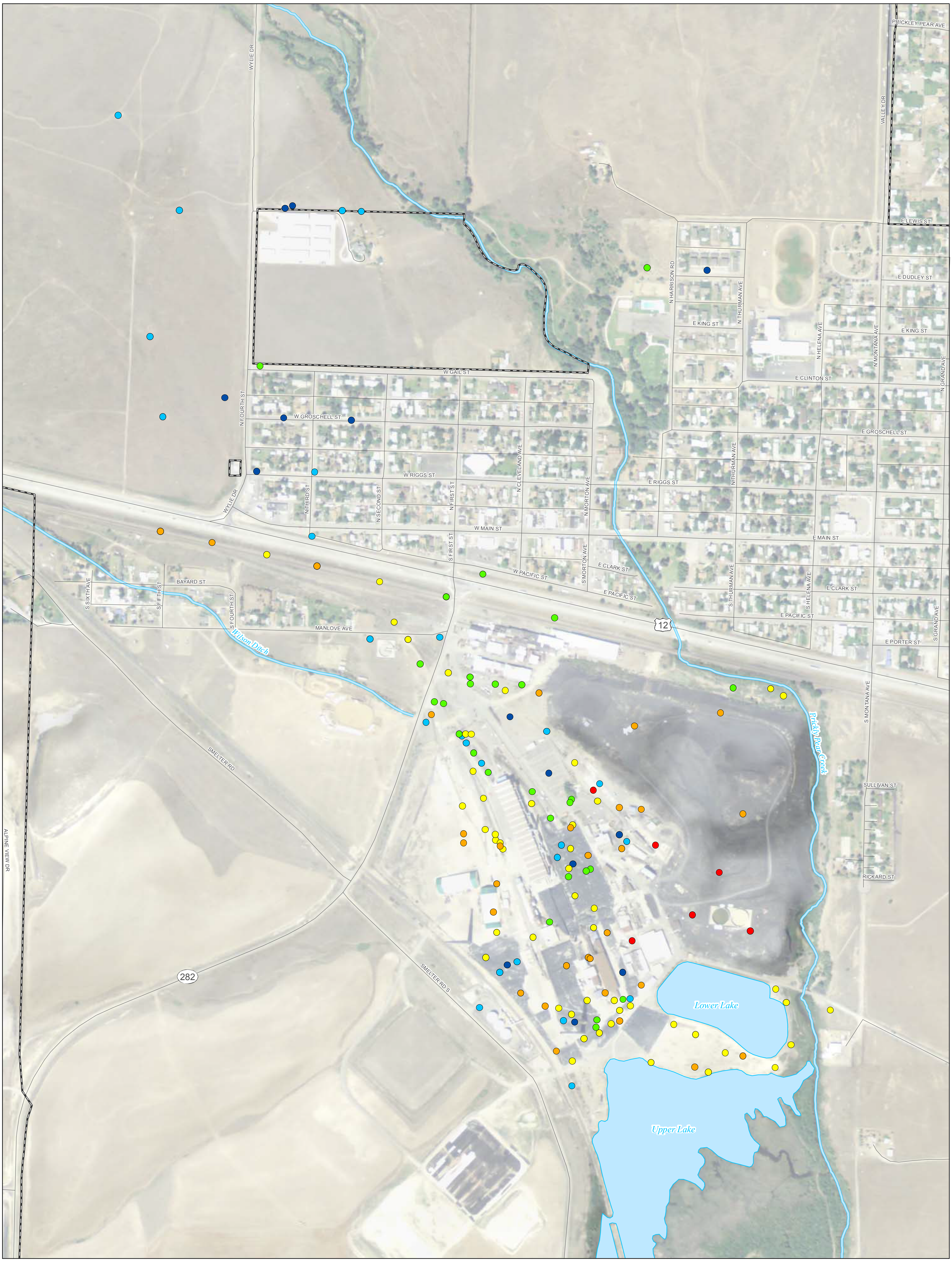
FIGURE 6-15b

Zinc Concentrations in Subsurface Soil (0.5 - 3.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-15b_Zn_in_Subsurface_Sed_A.mxd, Date: April 20, 2011 7:21:16 PM

Revised July 2014



LEGEND

Zinc Concentrations (mg/kg)

- >46,900
- >4,690 - 46,900
- >469 - 4,690
- >93.8 - 469
- >46.9 - 93.8
- <46.9
- Non-Detect

Screen Level Values (See Section 4)

Residential - 23,000 mg/kg
Industrial - 310,000 mg/kg
Groundwater Protection - NA
Background - 46.9 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

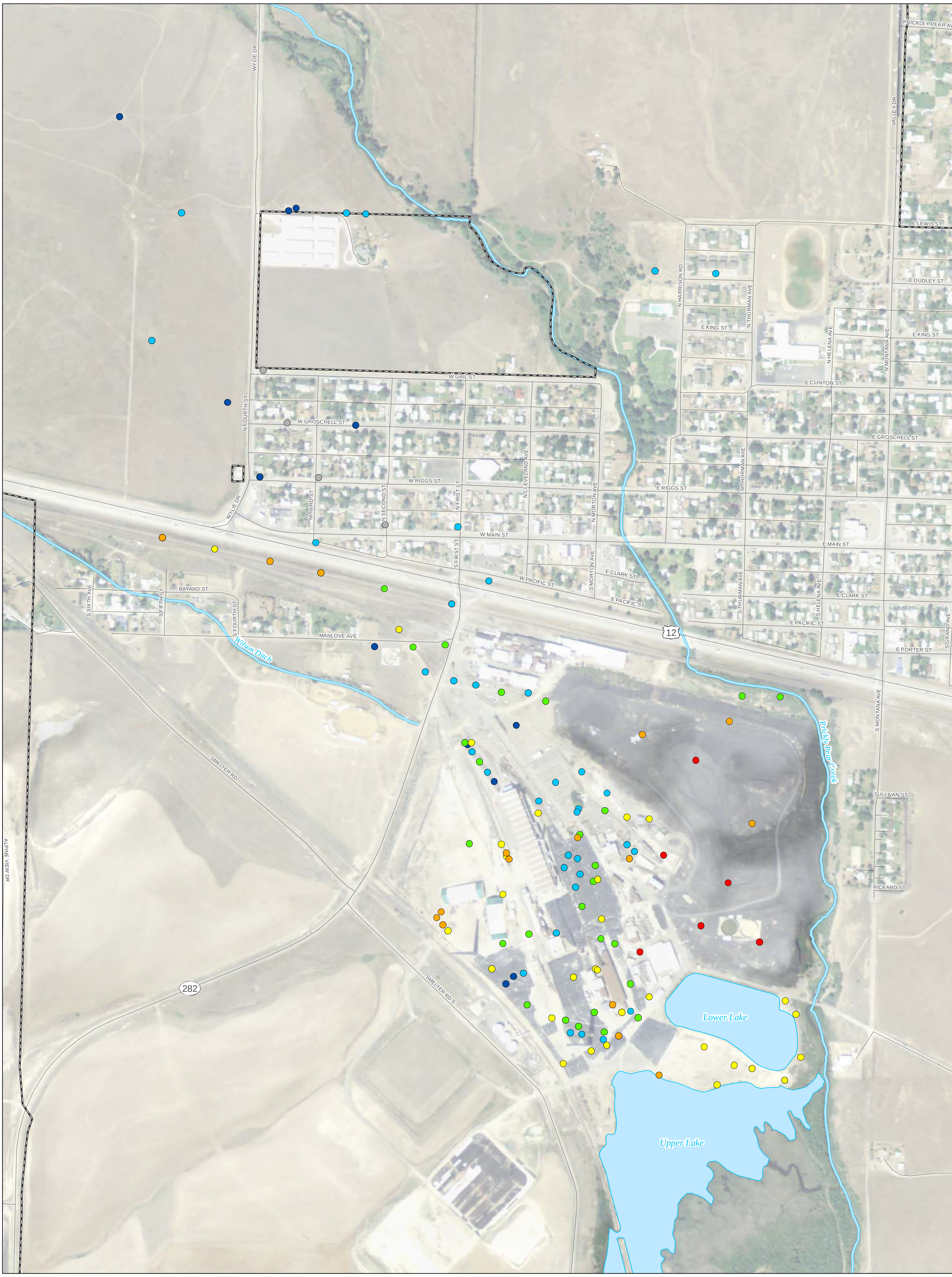
FIGURE 6-15c

Zinc Concentrations in Subsurface Soil (3.0 - 6.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-15c_Zn_in_Subsurface_Sed_B.mxd, Date: April 20, 2011 7:23:35 PM

Revised July 2014



LEGEND

Zinc Concentrations (mg/kg)

- >46,900
- >4,690 - 46,900
- >469 - 4,690
- >93.8 - 469
- >46.9 - 93.8
- <46.9
- Non-Detect

Screen Level Values (See Section 4)

Residential - 23,000 mg/kg
Industrial - 310,000 mg/kg
Groundwater Protection - NA
Background - 46.9 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

GSI Water Solutions, Inc.

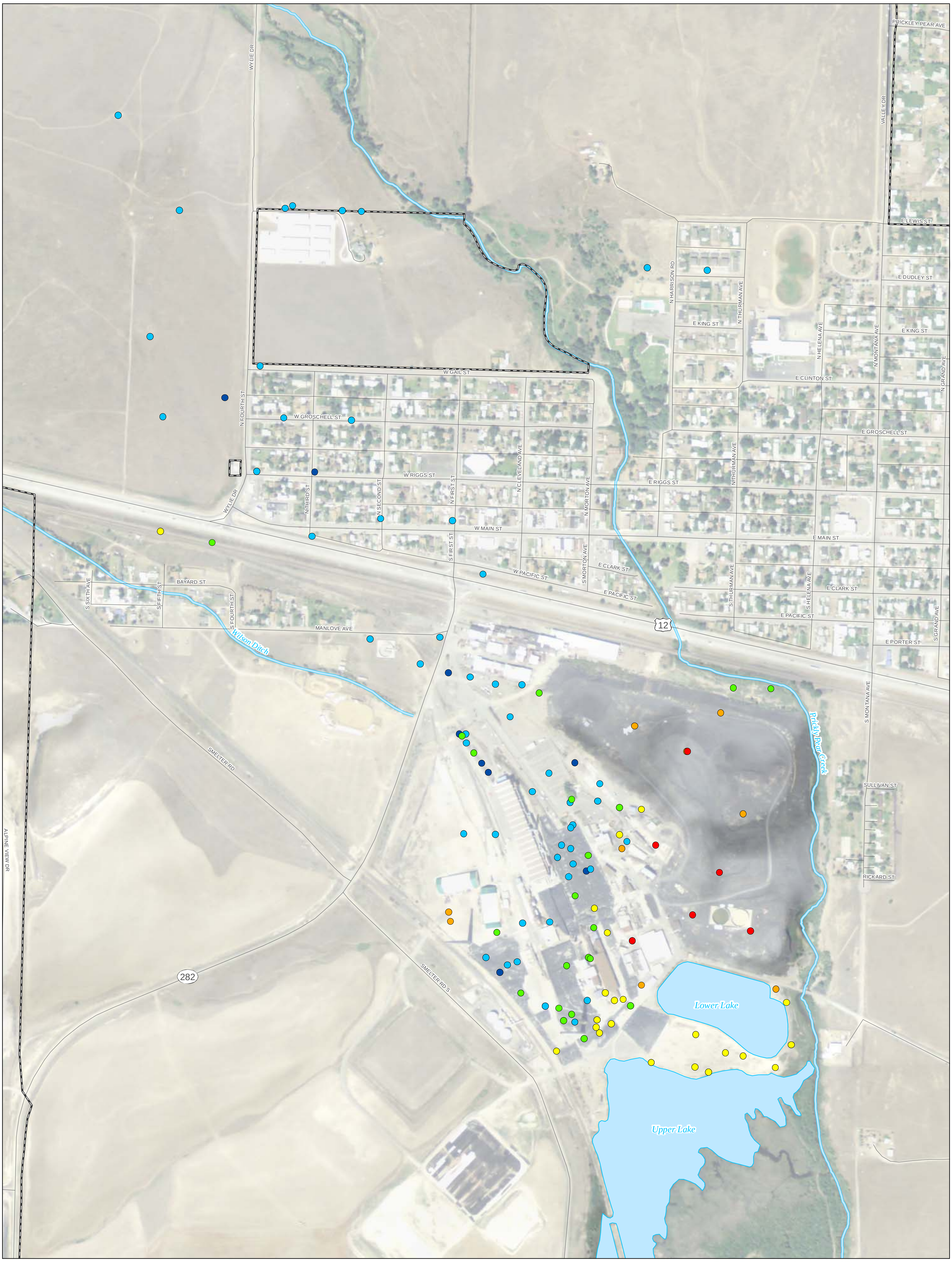
FIGURE 6-15d

Zinc Concentrations in Subsurface Soil
(6.0 - 10.0 ft bgs)

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-15d_Zn_in_Subsurface_Sed_C.mxd, Date: April 20, 2011 7:26:42 PM

Revised July 2014



LEGEND

Zinc Concentrations (mg/kg)

- >46,900
- >4,690 - 46,900
- >469 - 4,690
- >93.8 - 469
- >46.9 - 93.8
- <46.9
- Non-Detect

Screen Level Values (See Section 4)

Residential - 23,000 mg/kg

Industrial - 310,000 mg/kg

Groundwater Protection - NA

Background - 46.9 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:

Date: April 20, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900

Feet

FIGURE 6-15e

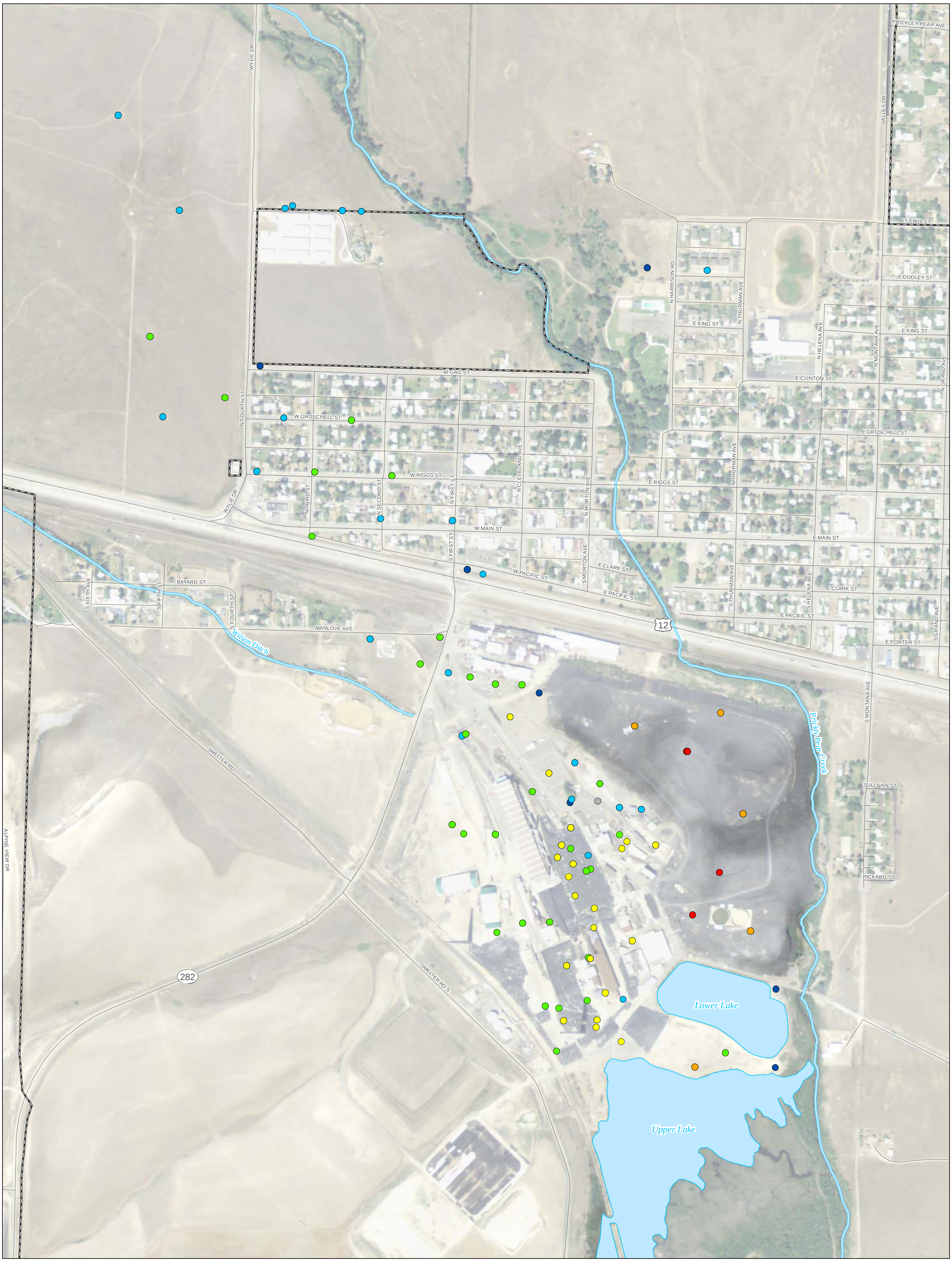
Zinc Concentrations in Subsurface Soil (10.0 - 20.0 ft bgs)

Phase II RFI Report
East Helena Facility

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-15e_Zn_in_Subsurface_Sed_D.mxd, Date: April 20, 2011 7:28:55 PM

Revised July 2014



LEGEND

Zinc Concentrations (mg/kg)

- >46,900
- >4,960 - 46,900
- >469 - 4,690
- >93.8 - 469
- >46.9 - 93.8
- <46.9
- Non-Detect

Screen Level Values (See Section 4)

- Residential - 23,000 mg/kg
- Industrial - 310,000 mg/kg
- Groundwater Protection - NA
- Background - 46.9 mg/kg

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 20, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 300 600 900
Feet

FIGURE 6-15f

Zinc Concentrations in Subsurface Soil
(>20.0 ft bgs)

Phase II RFI Report
East Helena Facility

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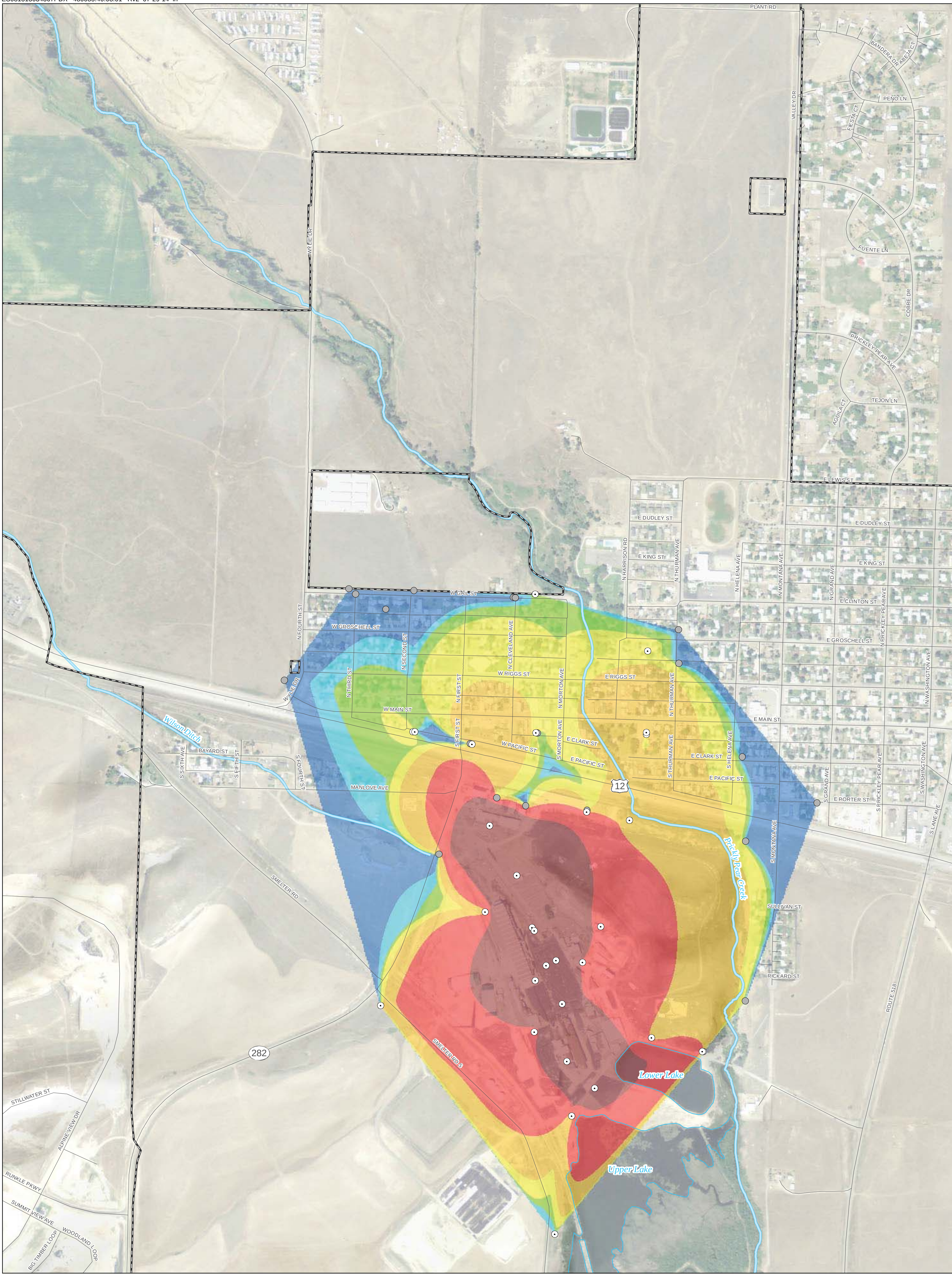
File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure6-15f_Zn_in_Subsurface_Sed_E.mxd, Date: April 20, 2011 7:31:11 PM

Revised July 2014

ES081313034307PDX 486085.46.08.01 Rv2 07-29-14 lh



LEGEND

Arsenic Concentrations (mg/L)
- >20
- >2 - 20
- >0.2 - 2
- >0.035 - 0.2
- >0.02 - 0.035
- >0.01 - 0.02
- <0.01

Groundwater Monitoring Locations
- Detect
- Non-Detect

Maximum Contaminant Level for Arsenic is 0.010 mg/L

All Other Features
- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 26, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

FIGURE 11-25a

Dissolved Arsenic Concentrations in Groundwater April - May 1988

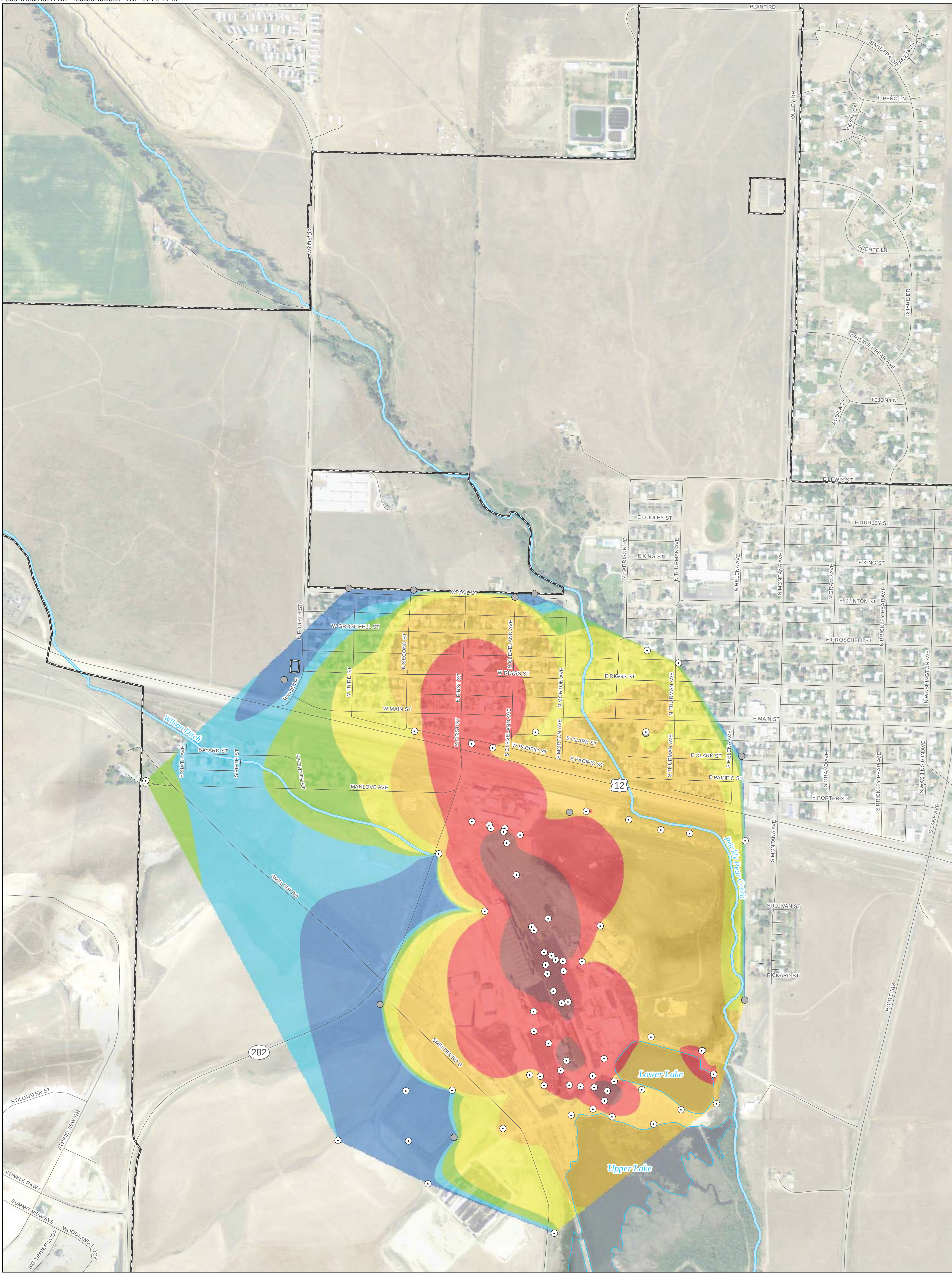
Phase II RFI Report
East Helena Facility

N

0 400 800 1,200
Feet

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure11-25a_NN_AprMay1988_As.mxd, Date: April 26, 2011 10:05:22 AM
Revised July 2014



LEGEND

Arsenic Concentrations (mg/L)

- >20
- >2 - 20
- >0.2 - 2
- >0.035 - 0.2
- >0.02 - 0.035
- >0.01 - 0.02
- <0.01

Groundwater Monitoring Locations

- Detect
- Non-Detect

Maximum Contaminant Level for Arsenic is 0.010 mg/L

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 26, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

FIGURE 11-25b

Dissolved Arsenic Concentrations in Groundwater October - November 2000

Phase II RFI Report
East Helena Facility

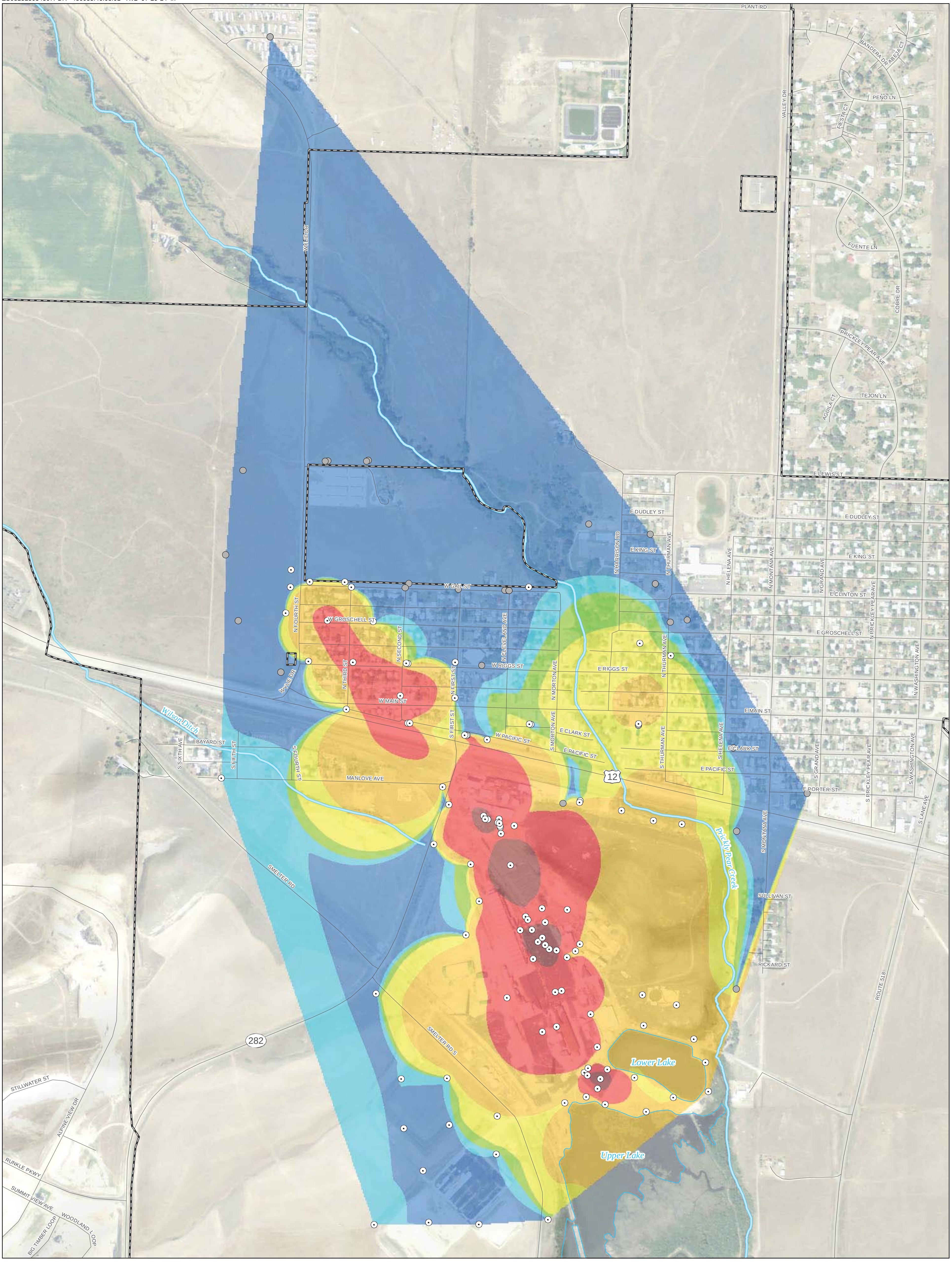
N

0 400 800 1,200
Feet

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure11-25b_NN_OctNov2000_As.mxd, Date: April 26, 2011 10:06:12 AM
Revised July 2014

ES081313034307PDX 486085.46.08.01 Rv2 07-29-14 lh



LEGEND

Arsenic Concentrations (mg/L)

- \>20
- \>2 - 20
- \>0.2 - 2
- \>0.035 - 0.2
- \>0.02 - 0.035
- \>0.01 - 0.02
- <0.01

Groundwater Monitoring Locations

- Detect
- Non-Detect

Maximum Contaminant Level for Arsenic is 0.010 mg/L

All Other Features

- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:

Date: April 26, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

0 400 800 1,200

Feet

GSI Water Solutions, Inc.

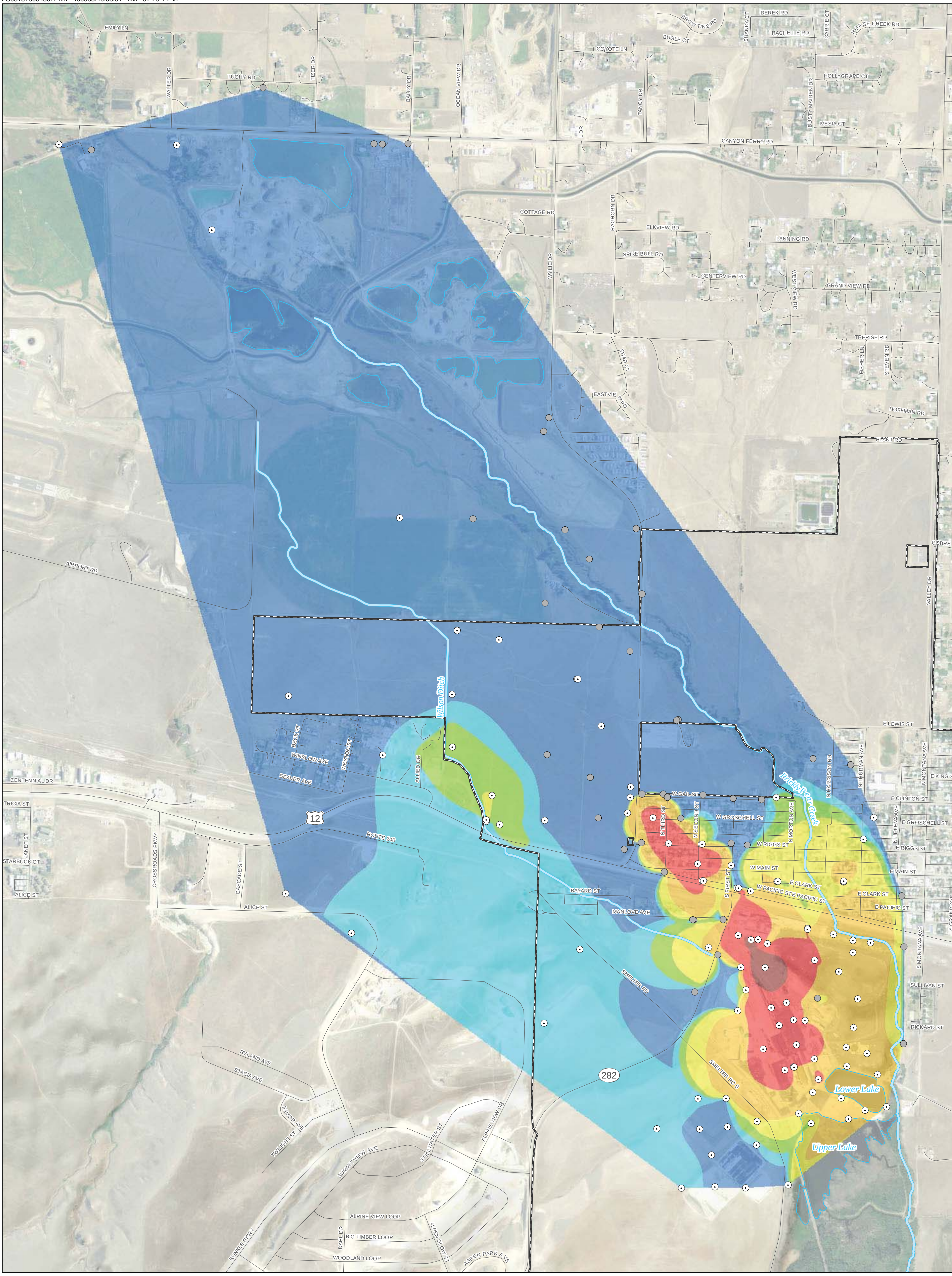
FIGURE 11-25c

Dissolved Arsenic Concentrations in Groundwater April - May 2008

Phase II RFI Report
East Helena Facility

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure11-25c_NN_AprMay2008_As1.mxd, Date: April 26, 2011 11:14:26 AM

Revised July 2014



LEGEND

Arsenic Concentrations (mg/L)
- >20
- >2 - 20
- >0.2 - 2
- >0.035 - 0.2
- >0.02 - 0.035
- >0.01 - 0.02
- <0.01

Groundwater Monitoring Locations
- Detect
- Non-Detect

Maximum Contaminant Level for Arsenic is 0.010 mg/L

All Other Features
- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 26, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

N

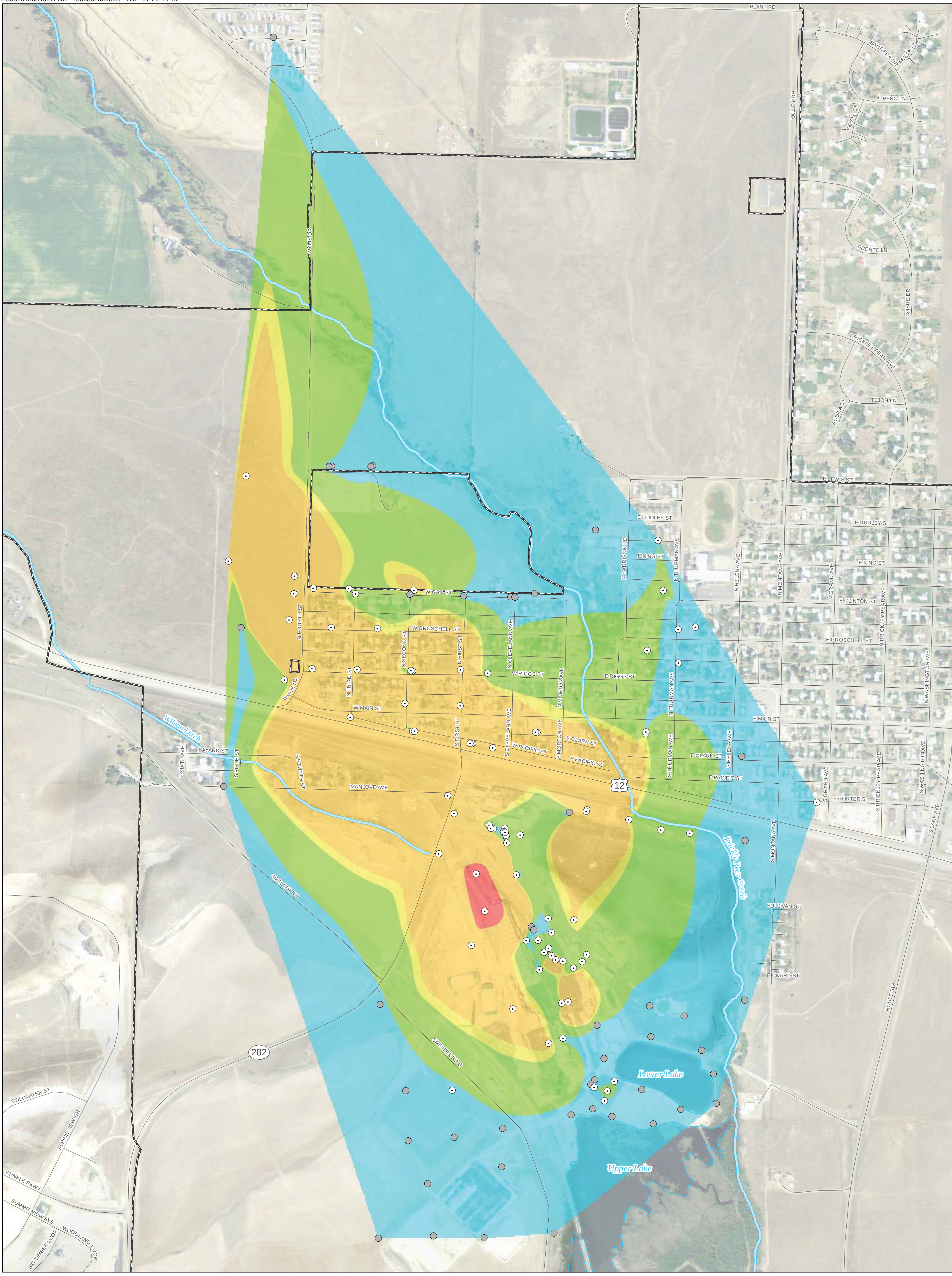
0 0.125 0.25 0.375
Miles

GSI Water Solutions, Inc.

FIGURE 11-25d

Dissolved Arsenic Concentrations in Groundwater October - December 2010

Phase II RFI Report
East Helena Facility



LEGEND

Selenium Concentrations (mg/L)
- >5
- >0.5 - 5
- >0.06 - 0.5
- >0.05 - 0.06
- >0.01 - 0.05
- >0.0005 - 0.01
- <0.0005

Groundwater Monitoring Locations
- Detect
- Non-Detect

Maximum Contaminant Level for Selenium is 0.050 mg/L

All Other Features
- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 25, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

FIGURE 11-26a

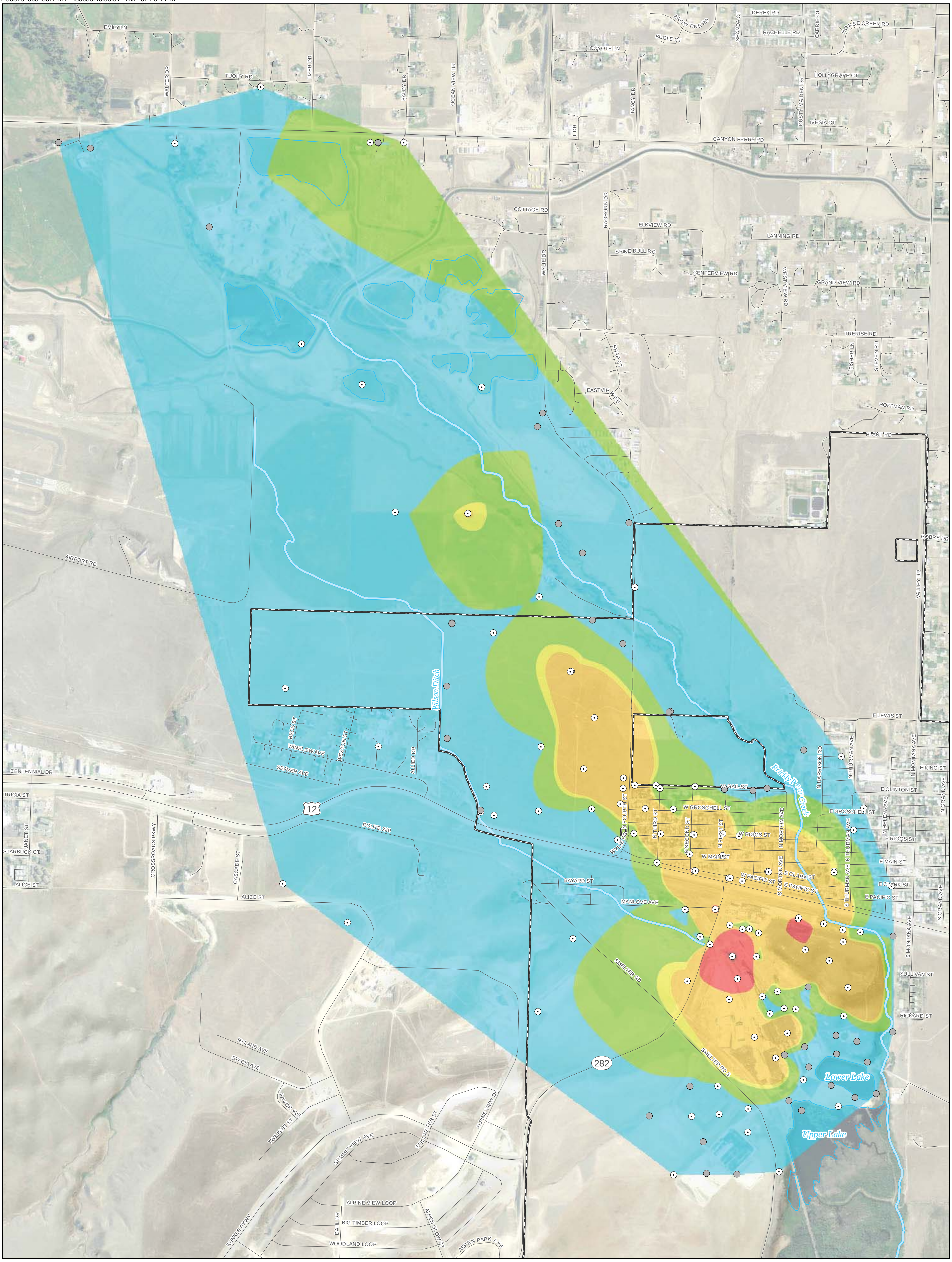
Dissolved Selenium Concentrations in Groundwater
April - May 2008

Phase II RFI Report
East Helena Facility

N
0 400 800 1,200
Feet

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure11-26a_NN_AprMay2008_Se.mxd, Date: April 26, 2011 1:23:02 PM
Revised July 2014



LEGEND

Selenium Concentrations (mg/L)
- >5
- >0.5 - 5
- >0.06 - 0.5
- >0.05 - 0.06
- >0.01 - 0.05
- >0.0005 - 0.01
- <0.0005

Groundwater Monitoring Locations
- Detect
- Non-Detect

Maximum Contaminant Level for Selenium is 0.050 mg/L

All Other Features
- East Helena City Limits
- Roads
- Surface Water Features

MAP NOTES:
Date: April 26, 2011
Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

FIGURE 11-26b

Dissolved Selenium Concentrations in Groundwater
October - December 2010

Phase II RFI Report
East Helena Facility

N

0 0.125 0.25 0.375
Miles

GSI Water Solutions, Inc.

File Path: P:\Portland\394-MT_Environmental_Trust_Group\001_MT_Environ_Asarco\Project_GIS\Project_mxds\Ph2_RFI_Report\Figure11-26b_NN_OctDec2010_Se2.mxd, Date: April 26, 2011 1:37:27 PM
Revised July 2014